OPERATION, MAINTENANCE
AND REPAIR PARTS

of the

BROWN & SHARPE

No. 000

PLAIN MILLING MACHINE

B·S

SECONDARY COPY

Operation, Maintenance and Repair Parts

of the

No. 000 Plain Milling Machine

For Machines Beginning Serial No. 2297

B·S

BROWN & SHARPE MFG. CO.
PROVIDENCE 1, R. I., U. S. A.

Printed in U. S. A. 502-000/3 5C-12-52

FOREWORD

The purpose of this book is to give a thorough practical working knowledge of the Brown & Sharpe No. 000 Plain Milling Machine and its equipment.

The Operator of this machine normally has only to press the Start button and load and unload the vise or fixture. However, the information presented in Chapter I on controls, adjustments and special operating features will give the operator a useful familiarity with the machine, resulting in greater self-confidence and the ability to note whether the machine is working properly. In addition, the operator who wishes to know the machine more completely will gain considerable further information from the remainder of the book.

The Set-up Man will need to be thoroughly familiar with the information in both Chapter I and Chapter II. The second chapter gives a quick and simple procedure for setting-up the machine for a job; and the next two chapters, on typical set-ups and additional equipment, will also be of particular value to the set-up man.

The Maintenance Man will be especially interested in Chapter V, which covers installation and maintenance. This chapter will be more readily understood and, consequently, maintenance or repair work will be done more easily if the maintenance worker is familiar with the facts explained in Chapter I. Additional help is provided by the Repair Parts section, which shows the parts of the machine laid out in correct relation to each other to facilitate identification and reassembly.

CONTENTS

PART I — OPERATION AND MAINTENANCE

PAGE

Introductory Illustrations 4

Controls, Adjustments and Principal Parts of the No. 000 Plain Milling Machine (4); Typical Production Set-ups (6).

CHAPTER I—Set-up Adjustments and Operating Controls 7

Special Operating Features (7); Table Controls and Adjustments (7); Spindle Controls and Adjustments (10); Arbor Support (12); Coolant System (13).

CHAPTER II—Setting-up the Machine 14

Step-by-Step Procedure for Quick and Easy Set-up.

CHAPTER III—Typical Operations 16

Representative Set-ups Illustrated and Described (16); Machines Equipped with Special Automatic Fixtures and Controls (20).

CHAPTER IV—Additional Equipment 22

Wash-out Arrangement (22); Hinged Arm Brace Arrangement (22); Arbor Center Head (23); Flanged Vise (23); Cam Vise (23); Spindle Speed Reducing Unit (23).

CHAPTER V—Maintenance 24

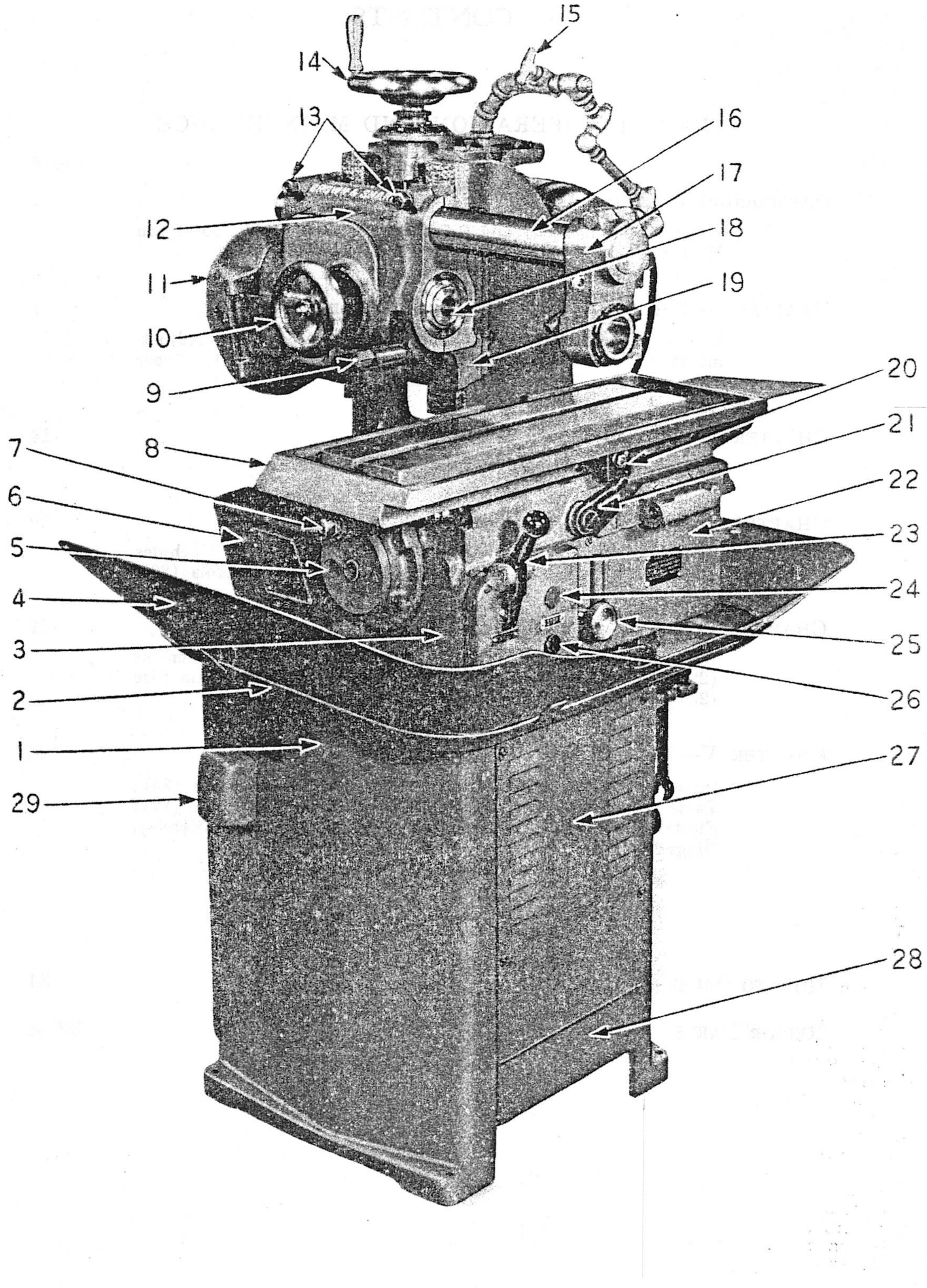
Installing or Relocating the Machine (24); Lubrication (24); Table Control Mechanism (26); Mechanical Adjustments (27); Electrical Controls (28); Operating Precautions (29); Electrical Diagrams (30).

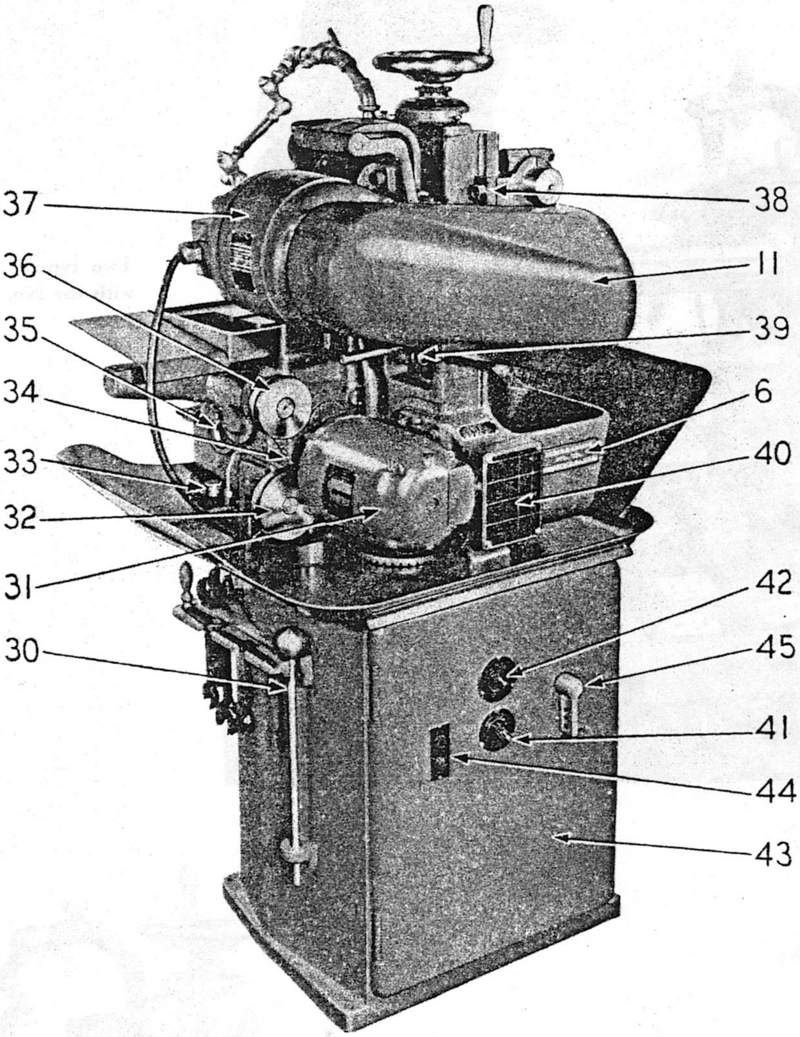
PART II — REPAIR PARTS

HOW TO ORDER REPAIR PARTS 31

REPAIR PARTS 32-45

Controls, Adjustments and Principal Parts of the No. 000 Plain Milling Machine

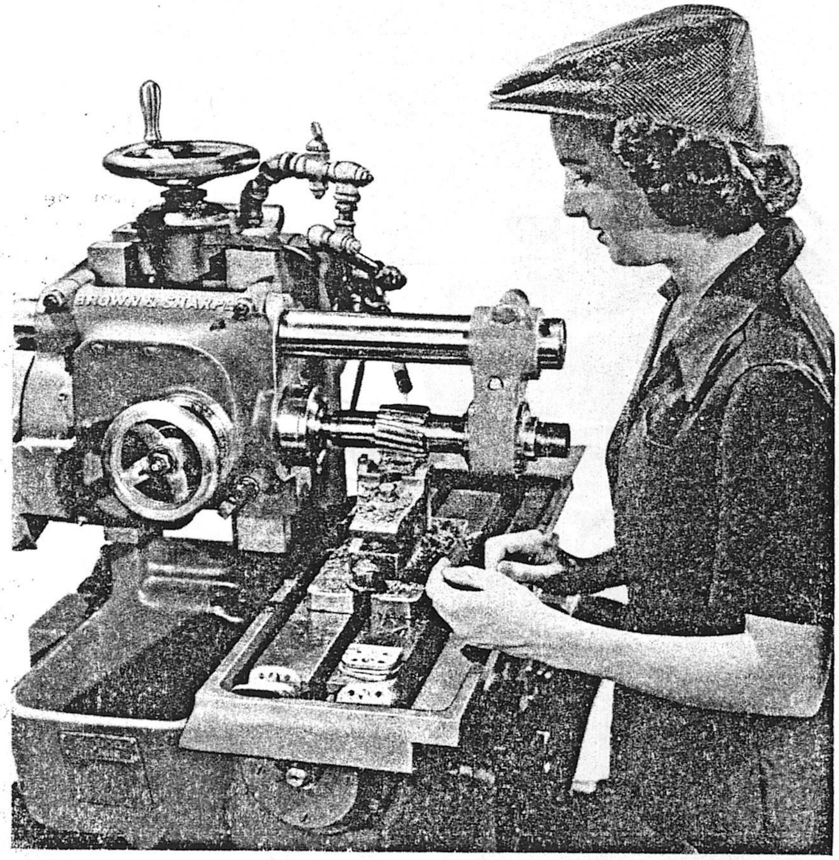




1 Base
2 Coolant trough
3 Bed
4 Coolant splash guard
5 Table cam position indicator
6 Chip tank
7 Table position adjusting nuts (on non-rotating table shaft)
8 Table
9 Spindle sleeve clamp bolt
10 Transverse adjustment handwheel
11 Spindle belt guard
12 Spindle head
13 Overarm clamp nuts
14 Vertical adjustment handwheel
15 Coolant valve and adjustable coolant piping
16 Overarm
17 Arbor yoke
18 Spindle sleeve and spindle
19 Spindle head clamping strap (front)
20 Feed trip dog
21 Feed trip lever
22 Feed change gear compartment
23 Start lever
24 Stop button
25 Fast travel engagement knob*
26 Table Return button*
27 Coolant tank and table counterweight (in base)
28 Feed change gear storage compartment
29 Power inlet (terminal box)
30 Knockout rod
31 Table motor
32 Counterweight chain idler pulley
33 Filler for oil reservoir in bed
34 Table counterweight chain
35 Sight indicator for automatic oiling system in bed
36 Counterweight chain pulley
37 Spindle motor
38 Spindle head clamping strap (rear)
39 Clamp nut for spindle belt tension adjustment
40 Spindle speed plate
41 Spindle reversing switch
42 Continuous-Intermittent spindle selector switch
43 Electrical control compartment
44 Coolant pump switch
45 Disconnect switch

---

*Used during set-up only.



Two typical production set-ups with the No. 000.

Single lever operating control and automatic milling cycle make this machine simple and easy to operate.

CHAPTER I

Set-up Adjustments and Operating Controls

This chapter explains the purpose and use of each of the machine's manual controls and set-up adjustments. In addition, a brief description of the table and spindle drives and automatic table controls is given as background information to further help the set-up man or maintenance worker.

A general familiarity with the machine will be gained from a study of the illustrations on pages 4 and 5; and the brief introductory material given below will aid in understanding the detailed information which follows.

Special Operating Features

The No. 000 Plain Milling Machine is a small, high-production manufacturing-type machine which has certain unique operating characteristics. The following facts should be kept in mind from the beginning:

— The table is driven by a cam, and has a path of movement which is always 6″ in length. The cam is built into the driving mechanism and is never changed.

— The work is always loaded and removed with the table at the left end of its path of travel, and the table moves to the right during cutting feed.

— In operation, the machine is started by pulling the Start lever at the front, and the table always has the following automatic cycle: (1) Advance to the right in fast travel; (2) go into cutting feed as controlled by the adjustable feed trip dog, and continue in feed until reaching the end of the 6″ total movement; (3) reverse and return to starting position (at extreme left) in fast travel; and (4) stop for reloading.

— Sixteen rates of cutting feed are provided by change gears as explained later. The fast travel rate in both directions is always 365″ per minute (with 60-cycle motor).

— The feed trip dog can be positioned to give any length of cutting feed from 3/8″ to 5½″.

— Table reversal is accurate to .002″.

Table Controls and Adjustments

Table Drive. The table is driven by a constant-speed reversible motor mounted on the right rear of the bed, independent of the spindle drive. The motor is coupled to the driving mechanism in the bed and rotates a drum-type cam, which in turn drives the table. For cutting feed the drive to the cam goes through change gears at the front, while for fast travel the cam is driven through a jaw clutch on the constant-speed camshaft. The design of the mechanism gives immediate automatic disengagement of the drive in case of sudden overload, with automatic reengagement when the load returns to normal.

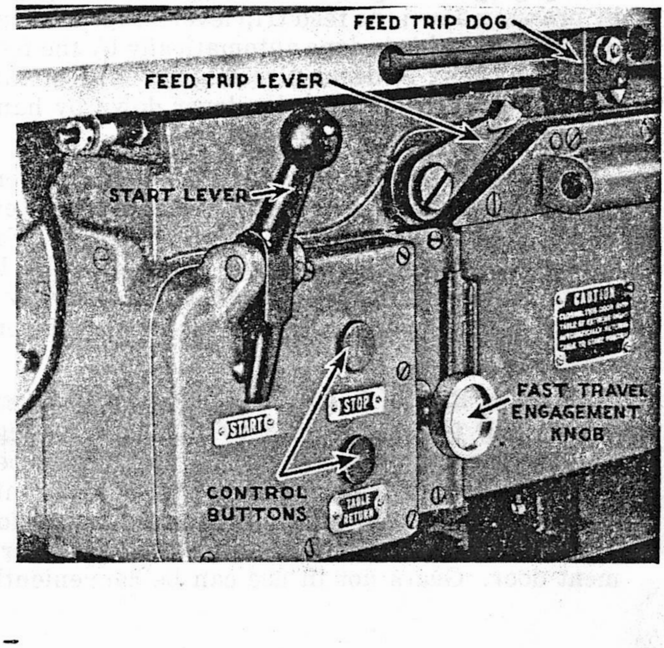
Automatic Controls. In operation, when the machine is started the table moves to the right in fast travel until the adjustable feed trip dog presses down the feed trip lever (Fig. 1) to engage cutting feed. When the table reaches the right-hand end of its movement, fast travel is engaged by a fixed dog or pin on the driving cam, and immediately thereafter another dog on the cam operates a switch to reverse the table motor. Consequently the table automatically returns to the left in fast travel; and as it reaches the left end of its movement a third dog on the cam opens a switch to stop the table motor, thus stopping the table. Fast travel drive remains engaged, so that when the machine is again started the table moves to the right in fast travel.

The three dogs on the table driving cam are fastened in position at our factory and are not adjusted during set-up or operation.

Control Lever and Buttons. Manual control of power table movements is provided by the lever and two push buttons at the left front of the bed, shown in Fig. 1.

The Start lever starts the table moving to the right, and also starts the spindle. The table will move in either fast travel or cutting feed, whichever happens to be engaged at the time the Start lever is pulled. During normal operation the table will start in fast travel as explained above.

Fig. 1. Table controls used during set-up. With the machine in operation, the operator uses the Start lever only.



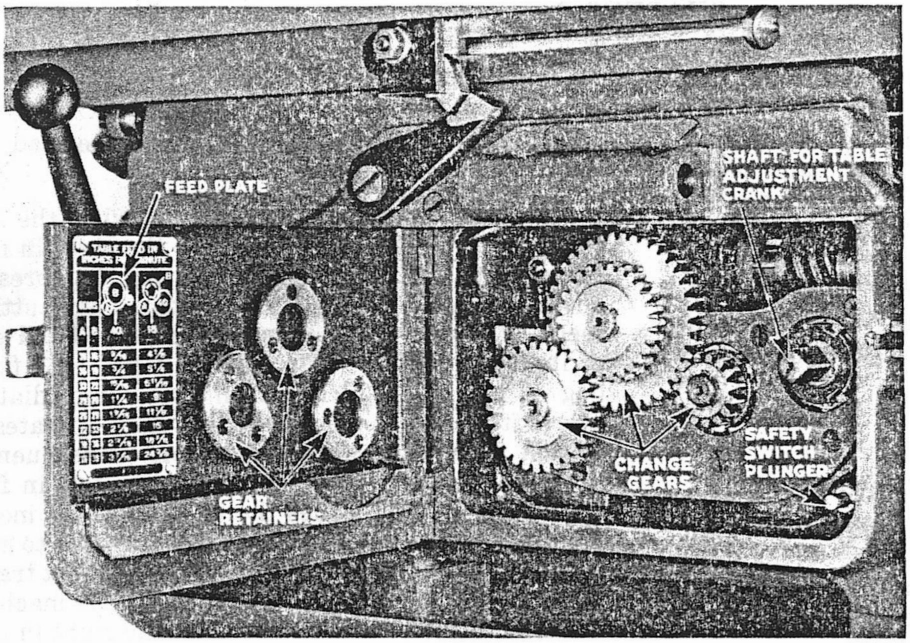


Fig. 2. Feed change gear compartment with door open, showing change gears in position. Retainers on door hold gears on shafts when door is closed. Safety switch keeps table motor from running while door is open.

Pressing the Table Return button causes the table to move to the left. If fast travel is engaged at the time this button is pressed, the table will move in fast travel; and if cutting feed is engaged, it will move in cutting feed. This control can be used when the table is either stopped or moving to the right. It is provided to facilitate set-up and is not used during regular operation.

The Stop button stops both the table and the spindle, and the machine remains stopped until it is started again by either pulling the Start lever or pressing the Table Return button. CAUTION: If the table is at the right-hand end of its path of travel when the Stop lever is pulled, it will start to the left in fast travel as soon as the lever is released.

Engaging Cutting Feed. Cutting feed is engaged by pressing down the feed trip lever (Fig. 1). During operation this is done automatically by the feed trip dog. If it is desired to engage feed at any point during set-up, push the lever down by hand or by tapping with a lead hammer.

Engaging Fast Travel. Fast travel drive is engaged automatically at the point of reversal as explained above under "Automatic Controls". For convenience in setting-up, fast travel can also be engaged manually at any point in the cycle by a short clockwise turn of the fast travel engagement knob (Fig. 1).

Selecting Rate of Feed. Rate of table movement for cutting feed is selected by means of change gears in the compartment in the front of the bed (see Fig. 2). The gears are readily slipped onto the multiple-splined shafts and are held in position by retainers fastened to the inside of the compartment door. Gears not in use can be conveniently stored on a shelf behind the hinged guard at the lower front of the base.

The feed plate (Fig. 2) is mounted on the inside of the door. Sixteen rates of feed are provided from $\frac{9}{16}$" to $24\frac{3}{8}$" per minute (with 60-cycl motor).

In setting-up, the gear on the right-hand shaft (called C in the feed plate) and the mating gear on upper shaft B are put on first. To obtain the feeds listed in the left-hand column of the feed plate, put the 40-tooth gear on B and the 15-tooth gear on C; and to obtain the feeds listed in the right-hand column, put the 15-tooth gear on B and the 40-tooth gear on C. Then put the required gears on left-hand shaft A and on shaft B as listed under A and B in the feed plate opposite the desired rate of feed.

Safety Switch. A spring-operated switch opens the circuit to the table motor when the feed change gear compartment door is open, permitting the table motor to run only when the door is closed. Thus the operator runs no risk of accident due to starting of the motor when using the table adjustment crank (see below) or when changing gears.

CAUTION: If the table is at its extreme right-hand position with the door open, it will automatically start to the left in fast travel when the door is closed.

Table Adjustment Crank. A crank for hand adjustment of the table position is furnished with the machine and is applied to the squared end of the right-hand shaft in the feed change gear compartment (Fig. 2). With fast travel engaged, the table movement is approximately $\frac{1}{4}$" per revolution of the crank.

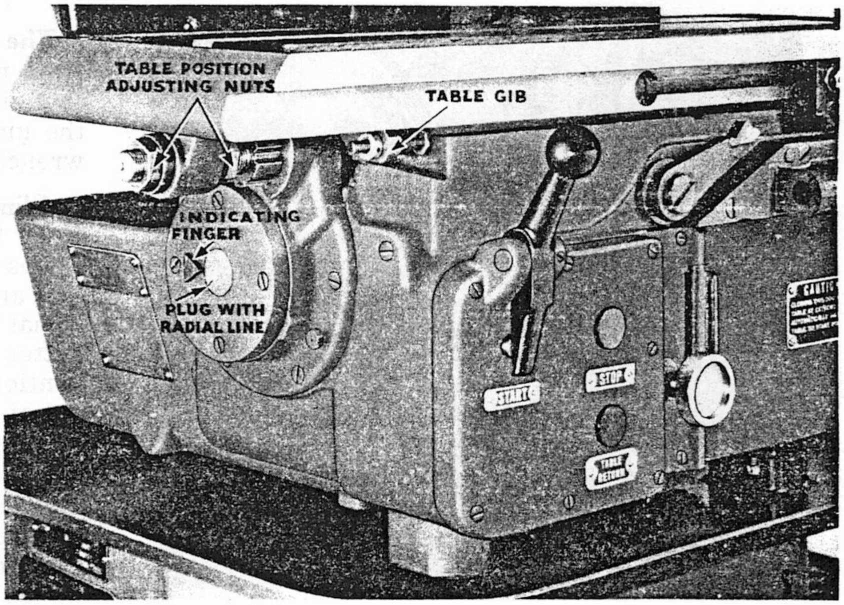


Fig. 3. Radial line on plug indicates position of table cam; lines up with indicating finger when table reaches right-hand end of movement. Table position adjusting nuts permit changing longitudinal position of table relative to cam.

Table Cam Position Indicator. This device (Fig. 3) shows when the table is at the right-hand limit of its path of movement. It consists of two parts—(1) a triangular red indicating finger, and (2) the disk-shaped outer surface of a plug in the end of the table cam. The plug carries a radial mark; and this mark lines up with the indicating finger when the table reaches the right-hand end of its travel.

As viewed in Fig. 3, the cam rotates clockwise to move the table to the right. Under some conditions it may be rotated a few degrees *beyond* the point where the radial mark lines up with the indicating finger. Due to the dwell in the cam, however, the table is known to be at its farthest-right position so long as the radial mark is either in line with the finger or beyond it in a clockwise direction.

Table Position Adjusting Nuts. The table is connected to the cam-driven non-rotating table shaft by means of the two adjusting nuts shown in Fig. 3, which bear against the lug on the underside of the table. This arrangement provides a ½″ longitudinal adjustment of the table with relation to the driving cam, and permits adjusting the position of the work relative to the cutter at the right-hand end of table travel without relocating the work on the table. (Use of this set-up adjustment is explained in item 15, page 15.) The thread is 16-pitch, permitting fine adjustments; a quarter-turn of the nuts moves the table about .016″ along the shaft.

Table Counterweight and Chain. The counterweight and chain system (Figs. 4, 5 and 6) acts through a pinion meshing with a rack on the table shaft, and is arranged to apply a constant load to the table in the same direction as the thrust of the cutter. This reduces the normal play or backlash in the table drive, enabling the machine to remove more metal without chatter. Note that climb milling and conventional milling require different arrangements of both chain and counterweights, as described below.

The counterweight itself is in the base and is reached by lifting off the sheet metal guard at the front. To reach the weights most easily, stop the table with the weights at the highest position as illustrated in Fig. 4. In changing the arrangement of the chain, support the counterweight on a board or block resting on the edges of the counterweight compartment.

For conventional milling, arrange the chain as shown in Fig. 5 (next page). Put the chain holder (at the top end of the chain) in the slot in the flanges of the upper pulley, and wind on the chain

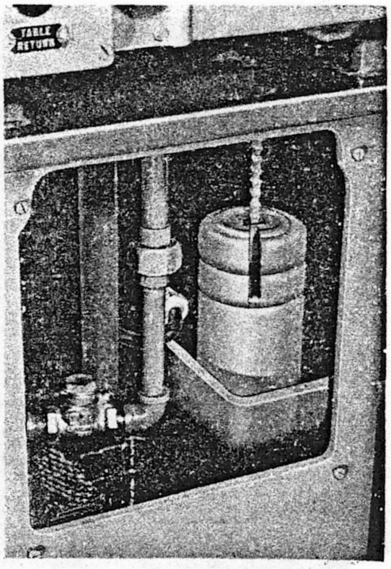


Fig. 4. Table counterweight, shown in upper position. The two small weights at the top are used for climb milling only, and should be removed for conventional milling.

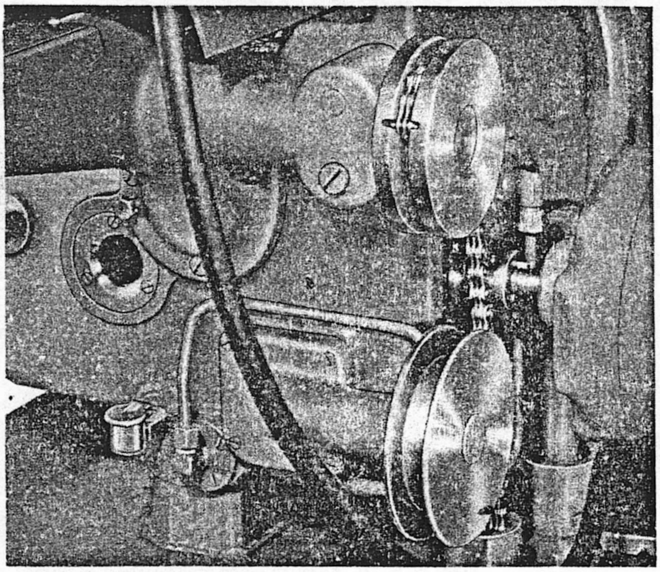


Fig. 5. Table counterweight chain arranged for conventional milling.

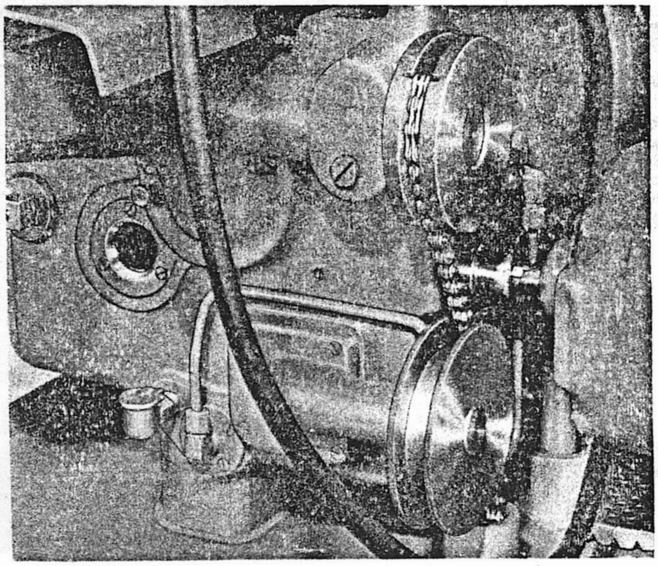
so it will leave the side of the pulley nearest the machine and run directly into the base.

For conventional milling use only the *large* weight; do *not* use the two small weights shown in Fig. 4.

For climb milling, arrange the chain as shown in Fig. 6. Put the chain holder in the slot in the flanges of the upper pulley, and wind on the chain so as to leave the upper pulley at the side farthest from the machine. The chain in this case is guided into the base over the idler pulley as illustrated. These arrangements are shown clearly on the plate on top of the table feed shaft extension bearing.

Note that the two small counterweights should be added to the large weight for climb milling.

Fig. 6. Chain arranged for climb milling.



The table gib should be loosened a little befor climb milling, to assure smooth table action. When changing back to conventional milling, retighten the gib. The gib is shown in Fig. 3, and a pin wrench is furnished for making adjustments.

Climb Milling, with the cutter teeth entering the work from above, simplifies the milling of many pieces which are thin, narrow or of irregular shape and are consequently difficult to hold for conventional milling; for the downward pressure of the cutter teeth seats the work firmly, whereas in conventional milling the cutter tends to lift the work out of the holding device.

While the No. 000 Plain Milling Machine is not designed specifically for climb milling, there are many conditions under which work of that type can be successfully performed on this machine. In general, jobs involving light cuts can usually be climb milled without difficulty. If the user is in doubt as to whether a given cut can be taken by climb milling, the Brown & Sharpe Milling Machine Engineering Service Department will be glad to make recommendations on receipt of adequate information as to proposed spindle speed, feed rate, depth of cut, width of cutter, nature of the material to be milled, and finish and accuracy desired.

Spindle Controls and Adjustments

Spindle Drive. The spindle is driven by a constant-speed motor mounted on a hinged bracket on the spindle head, through a V-belt and 4-step pulleys. Drive is either (1) direct, with the spindle pulley on a sleeve at the back end of the spindle (Fig. 7), or (2) through a single pair of speed-reduction gears enclosed in the spindle head, with the pulley on a sleeve on the end of the back gear shaft (Fig. 8).

Selecting Rate of Speed. Rate of spindle speed is selected by means of the 4-step pulleys shown in Figs. 7 and 8. The pulleys are interchangeable; and each pulley is held in position by a knurled nut, which should be securely tightened by hand before starting the machine.

The speed plate is mounted on the rear of the machine below the spindle belt guard, and shows the 16 rates available and the arrangement of driving belt and pulleys to obtain them. With a 60-cycle motor, the speed range is 105 to 2340 r.p.m. (range of 161 to 3540 r.p.m. optional when specified).*

A mechanical interlock prevents the spindle back gear from being engaged (and hence running at excessive speed) when the spindle is driven directly.

---

*A lower speed in each range is also available by means of the Spindle Speed Reducing Unit described on page 23.

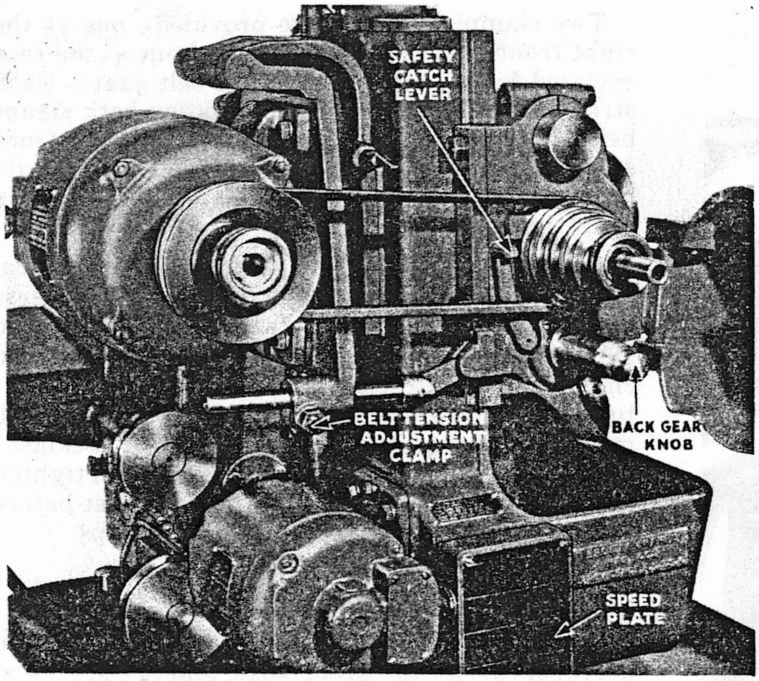


Fig. 7. Spindle drive with guard swung open, showing pulley on spindle for direct drive.

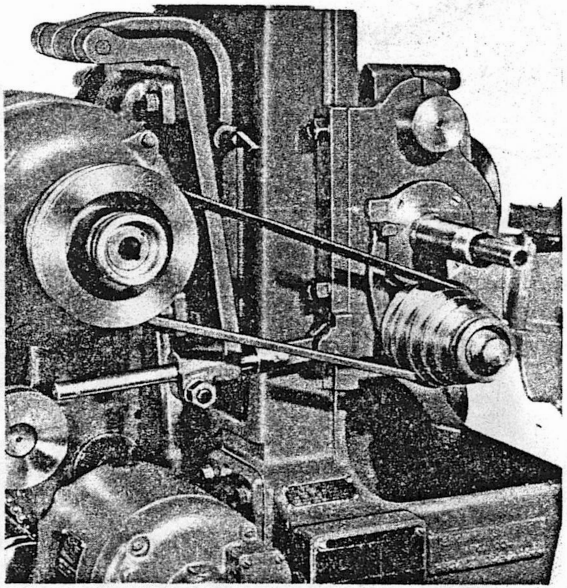


Fig. 8. Spindle drive (guard swung open) with pulley on back gear shaft.

To put the driving pulley on the spindle as in Fig. 7, first push in the knob at the end of the back gear shaft to disengage the back gear. This permits the safety catch lever (shown in Figs. 7 and 8) to be pulled to the left, locking the back gear out of engagement and allowing the pulley to be slid into place on the spindle.

To engage the back gear when the pulley is used on the back gear shaft (Fig. 8), move the safety catch lever to the right; then pull the back gear knob outward, rotating it if necessary to mesh the gears. A detent on the shaft holds the back gear engaged with the gear on the spindle.

Belt Tension Adjustment. The spindle motor is mounted on a vertical bracket which is hinged horizontally at the top, permitting easy regulation of tension in the driving belt.

To loosen the belt for changing speed, release the clamp nut at the lower end of the motor bracket (Fig. 7) and swing the motor toward the spindle.

To tighten the belt, pull the motor away from the spindle with one hand and at the same time test the tension and tighten the clamp nut with the other hand. The tension is correct when a force of about 5 lbs. between the thumb and fingers at mid-span brings the two sides of the belt about an inch closer together.

Reversing the Spindle. The desired direction of spindle rotation is obtained by means of the lower of two selector switches on the rear of the base (Fig. 9), which reverses the spindle motor. With the switch at Off position, only the spindle motor is disconnected.

It should be kept in mind that a change from direct drive to back gear drive or vice versa changes the direction of spindle rotation. The original direction of rotation can be obtained, if desired, by turning the reversing switch.

Continuous-Intermittent Control. The Continuous-Intermittent switch (Fig. 9) is on the back of the base above the spindle reversing switch. When set at Continuous, the spindle starts when the Start lever at the front of the machine is pulled, and runs continuously until the Stop button is pressed.

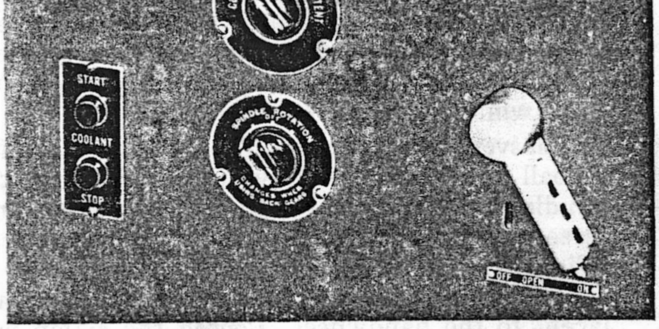


Fig. 9. Spindle, coolant and disconnect switches on rear of base.

With the switch set at Intermittent, the spindle runs only while the table motor is running in the direction required to move the table to the right.

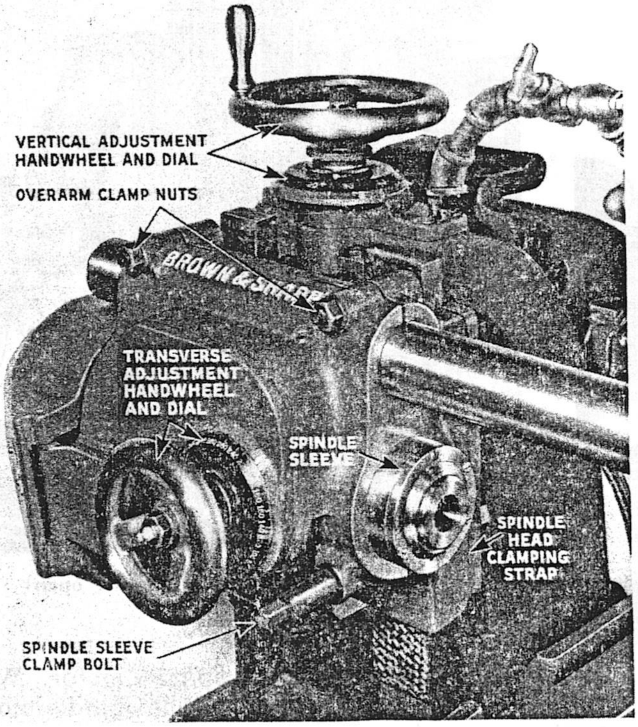

VERTICAL ADJUSTMENT HANDWHEEL AND DIAL
OVERARM CLAMP NUTS
BROWN & SHARPE
TRANSVERSE ADJUSTMENT HANDWHEEL AND DIAL
SPINDLE SLEEVE
SPINDLE HEAD CLAMPING STRAP
SPINDLE SLEEVE CLAMP BOLT

Fig. 10. Spindle head adjustments.

Power to the spindle motor is shut off when the table reverses, and the spindle remains stopped while the table is stopped. This setting is often used as a safety measure on jobs where the work or the operator's hand must be brought near the cutter when loading or unloading work.

During set-up, continuous spindle rotation is sometimes required without power movement of the table—for example, when clamping the arbor yoke, or perhaps for feeding the table by hand for a trial cut. This condition is obtained as follows:

Set the Continuous-Intermittent switch (Fig. 9) for Continuous operation. With no work in the vise or fixture, pull the Start lever and let the table run through one complete cycle and stop. The spindle will continue to run with the table stopped; and if desired, the feed change gear compartment door can be opened and the table moved by hand-crank while the spindle continues to run.

Transverse Adjustment. The spindle is carried on ball bearings in a sleeve in the front of the spindle head and is moved in or out by the transverse adjustment handwheel on the side of the head (Fig. 10).

The spindle sleeve is clamped by the bolt adjacent to the handwheel. Loosen the clamp bolt before making adjustments, and tighten it before taking a cut.

Vertical Adjustment. Vertical adjustment of the spindle head is made by the handwheel at the top of the machine (see Fig. 10).

Two clamping straps are provided—one at the right front of the spindle head, and one at the rear enclosed for the most part by the belt guard. Each strap is clamped by two nuts. Loosen both straps before making adjustments, and tighten the front strap before taking a trial cut. Both straps should be securely tightened before starting production operation.

Adjustable Dials. The transverse and vertical adjustments have adjustable dials, the transverse dial reading to .002″ and the vertical reading to .001″. To set either dial, turn the adjacent knurled clamp nut counterclockwise to release the dial; turn the handwheel in the direction of intended movement enough to take up the normal backlash; then turn the dial to the desired setting and tighten the clamp nut. The dials are preferably set before loosening the respective adjustment clamps.

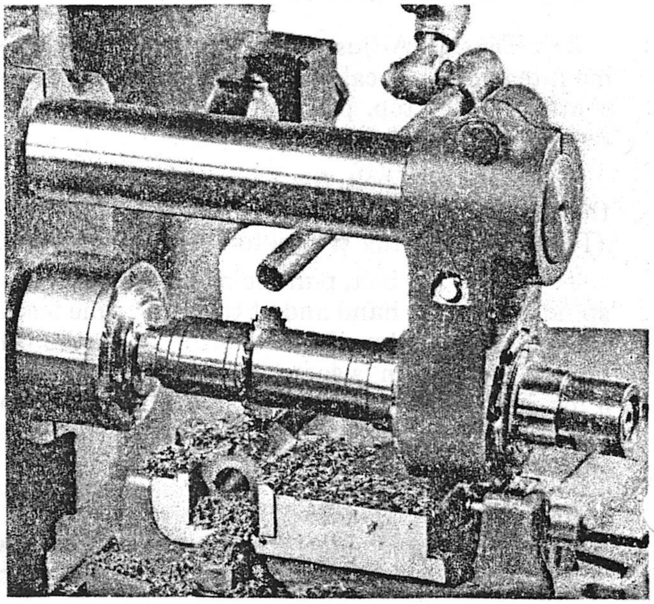
Arbor Support

Overarm. The adjustable solid steel cylindrical overarm carries the arbor yoke, and is clamped at both the front and rear of the spindle head by nuts (Fig. 10). When the two clamp nuts are released the overarm is easily moved in or out of the head. Tighten both nuts after adjusting the overarm.

Arbor Yoke. The arbor yoke (Fig. 11) supports the cutter arbor and has an adjustable bronze bushing which takes arbor sleeves 1⅞″ diameter. To tighten the bushing, first loosen the rear nut; then take up on the front nut until the bushing has a free running fit with the arbor and tighten the rear nut.

The bushing is lubricated through an oil hole cover on the left-hand side of the yoke.

Fig. 11. Arbor yoke.



In setting-up, locate the arbor yoke as close as possible to the cutter in order to give maximum support; then clamp it to the overarm by tightening the bolt at the top. The spindle should be running while the arbor yoke is being clamped, so that the rotating arbor will keep the arbor yoke bushing accurately in line with the spindle. Continuous spindle rotation without table movement is obtained as described on page 11.

Coolant System

The Coolant System, shown in illustrations throughout this book, consists of a motor-driven centrifugal pump, check valve, control valve, swivel-jointed distributor pipe and all necessary piping and connections, together with a sheet metal splash guard which fits on the coolant trough and a push-button-type manual starter having overload protection.

The pump and the 4-gallon coolant tank are inside the base as shown in Fig. 12, the tank being a part of the base casting. Coolant passes through a strainer before reaching the pump intake. The pump is started and stopped independent of the machine driving motors by means of a push-button switch installed in the electrical control compartment in the back of the base.

The check valve is located in the base near the pump outlet, and keeps the vertical piping full of coolant to give immediate splashless flow when the pump starts. If a condition should ever arise where the coolant starts each time with a surge or splash, the check valve needs cleaning.

A chip tank is included in the bed casting of the machine and is fitted with a removable perforated chip strainer. The coolant drains off through a hole in the bottom of the tank. A plug in the left side of the tank can be removed for extra drainage if necessary.

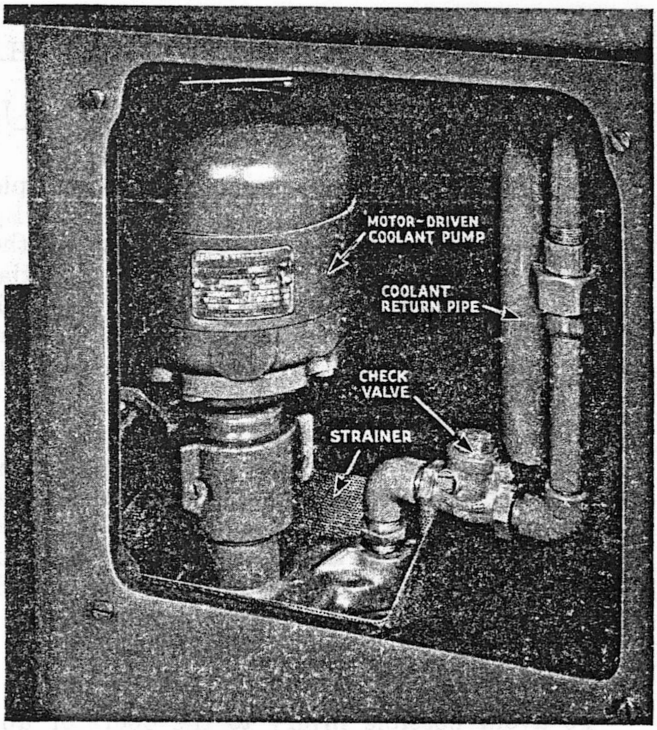


Fig. 12. Coolant tank and pump in base compartment (cover removed).

With the Coolant System in use, the coolant returns through a spillway in the back of the table to the chip tank, through the chip tank to the pan or trough at the top of the base, and then through a strainer and pipe to the coolant tank in the base.

CHAPTER II

Setting-Up the Machine

This chapter outlines a quick, safe and simple procedure for setting-up the machine for a job. By systematically taking the necessary steps in the order in which they are given below, no essential adjustment will be overlooked, possibility of accident will be reduced to a minimum, loss of time through needless repetition of certain steps will be avoided and set-up will be completed quickly and without difficulty.

The various controls and adjustments mentioned in this chapter are illustrated and described in detail in Chapter I; and this information should be referred to as often as necessary to make certain that the location, purpose and correct use of each control and adjustment is clearly understood.

Table

To avoid possible injury to the operator and damage to the cutter equipment, it is recommended that the initial table adjustments be completed before making the spindle adjustments, with no cutter or arbor in the spindle.

1. First, see that the lug or projection under the left end of the table is positioned approximately midway along the threaded portion of the table shaft (see Fig. 3, page 9). Relocate it if necessary by means of the adjusting nuts, making sure that both nuts are clamped firmly against the lug on completing the adjustment. This setting makes available later a final adjustment of work relative to cutter of 1/4" in either direction without relocating the vise or fixture on the table.

2. Place the feed trip dog at the left-hand end of its T-slot, where it will be out of the way.

3. Arrange the feed change gears (page 8) to give the rate of table feed desired. Use the fastest rate permitted by the width and depth of cut, type and hardness of the material being milled, and accuracy and finish required.

4. Check the arrangement of the table counterweight chain and number of counterweights in use (pages 9 and 10) and rearrange if necessary to suit the type of milling (climb or conventional) to be employed.

5. Using the table adjustment crank, bring the table to the extreme right-hand end of its path of travel as shown by the table cam position indicator at the left end of the bed (Fig. 3, page 9). If the table should happen to be in cutting feed, engage fast travel for more rapid movement by means of the fast travel engagement knob (Fig. 1, page 7).

On completing this adjustment, leave the handcrank on its shaft to prevent closing the gear compartment door; for if the door is closed, the table will instantly return to loading position at fast travel.

6. Set the vise or fixture on the table of the machine and clamp a work-piece in it. Then, leaving the table at the point of reversal as set by step 5, position the vise or fixture along the table so that the work-piece and the cutter (when installed) will be in approximately the relation desired at the finish of the cut. On through-cut work this usually means that the end of the cut should be slightly beyond the center of the spindle. On blind-cut work, where the cutter goes only part way across or into the work-piece, locate the piece so that the end of the cut will come at a distance equal to slightly less than half the cutter diameter to the left of the center of the spindle. This setting in either case should be made as close as possible by eye, but need not be exact; a final adjustment will be made later.

Securely clamp or bolt the vise or fixture to the table in the position thus arrived at, making sure that it is also seated flat on the table and in correct alignment with the table T-slot.

To permit maximum rigidity of cutter support, the fixture should be designed so that the cut will be taken as close to the spindle nose as possible, and should also permit the arbor yoke to be placed close to the cutter.

7. Move the table a sufficient distance to the left and clamp the feed trip dog in a position where cutting feed will be engaged at least 1/4" from the start of the cut. This is a precautionary measure, to prevent running the work into the cutter at fast travel while setting-up; finer adjustment is to be made later. In positioning the dog, keep in mind that feed is not engaged until the dog has nearly reached the high point on the feed trip lever.

Spindle

8. Insert the cutter arbor, adapter or end mill in the spindle, first making sure that both the tool shank and the spindle hole are perfectly clean. The spindle has a No. 9 B & S taper hole; and cutter equipment used in this machine is driven by a tang end and should be securely seated in the spindle, tapping with a lead hammer if necessary.

To remove cutter equipment from the spindle, open the spindle belt guard and insert the knockout rod furnished. Use one hand to rap with the rod while holding the arbor or cutter with the other hand.

For maximum cutter rigidity, run the spindle sleeve forward (out of the spindle head) as far as conditions permit so as to keep the distance from spindle nose to cutter as short as possible.

9. Clamp the overarm in the desired position and put on the arbor yoke. Adjust the arbor yoke bushing if necessary (see page 12). Place the arbor yoke as close to the cutter as the work and fixture will permit, and clamp it to the overarm with the spindle rotating.

If the Hinged Arm Brace Arrangement is to be used, it should be set up along with the arbor yoke as described on page 22.

10. Arrange the spindle driving belt and pulleys to give the desired spindle speed (page 10). In selecting the speed, take into consideration the type and hardness of the material being cut, the cutter diameter and number of teeth, rate of table feed, depth and width of cut, type of milling (climb or conventional), and finish desired.

11. Check the direction of spindle rotation, and change it if necessary by turning the spindle reversing switch on the rear of the base (Fig. 9, page 11).

12. Set the spindle to rotate either continuously or only when the table is moving to the right, whichever the job requires, by means of the Continuous-Intermittent switch (Fig. 9).

13. Adjust the coolant supply for the desired volume and distribution of coolant.

14. Bring the cutter into operating position by means of the transverse and vertical adjustment handwheels and adjustable dials (Fig. 10, page 12). Loosen the respective adjustment clamps before making adjustments and tighten them before taking a cut, as explained on page 12.

Trial cuts are conveniently taken by power feed. The table may be returned quickly to starting position at any time during a cut by pressing the Table Return button to reverse the movement and turning the fast travel knob to engage fast travel. Be sure to reverse the table before engaging fast travel.

The cutter can often be positioned more quickly by placing a previously-finished piece in the fixture rather than a blank. With the spindle belt guard open, turn the spindle slowly by hand to test whether the cutter is touching or just clearing the cut.

Final Adjustments

15. With a blank piece in the fixture, run through a complete operating cycle by power, and on a blind-cut job check the length of cut. On a through-cut job, for maximum production efficiency, note whether the table reverses as soon as the cutter action is completed. In most instances this will be when the end of the cut has passed just beyond the center of the cutter.

By means of the table position adjusting nuts, make any necessary change in the position of the work with relation to the cutter at the point of table reversal. This is best done by noting the amount of adjustment required and running the table to the left before actually making the adjustment.

If the cut is too short—that is, if the work is not fed a sufficient distance under the cutter before the table reverses—turn the adjusting nuts in a clockwise direction as seen from the left end, loosening the inner nut and tightening the outer nut, so as to move the table the required distance to the right along the table shaft.

If, on a blind cut, the length of cut is too great—or, on a through-cut job, the cutter is "cutting air" before the table reverses—turn the adjusting nuts counterclockwise so as to move the table to the left along the table shaft the amount required to correct the condition.

Make certain that both of the adjusting nuts are tight before taking a cut.

16. To further increase production efficiency, make a final setting of the feed trip dog so that the non-cutting time while advancing in feed will be reduced to a minimum. In general, the work can be safely advanced at fast travel to a distance of $1/16''$ from the cutter.

CHAPTER III

Typical Operations

The production jobs shown in this chapter are representative of the work performed on this machine. While no attempt has been made to describe each job in detail, the main features of set-up and operation are outlined as a guide to good milling practice.

Highly productive in its standard form, this machine is also readily converted to a single-purpose production unit through changes in its mechanism or the addition of automatic fixtures; and several arrangements of this type are also illustrated.

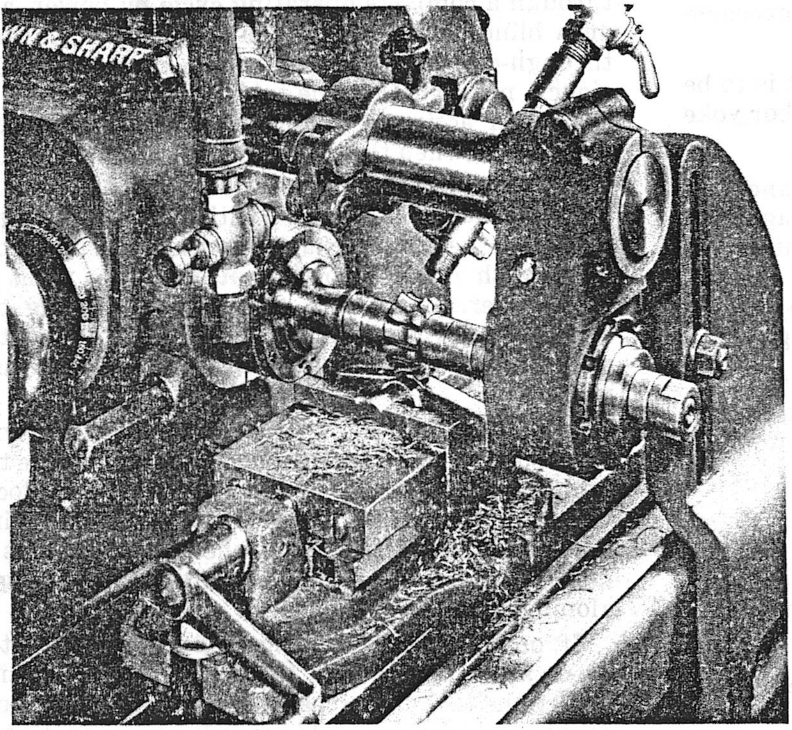


Fig. 13. Form-milling a sewing machine part. The work-piece is held in special vise jaws. Since this is a heavy cut in steel requiring both accuracy and good finish, the machine spindle sleeve is brought forward as far as possible to permit locating the cutter close to the spindle nose; and further rigidity is obtained by having the arbor yoke close to the cutter and by using the Hinged Arm Brace Arrangement.

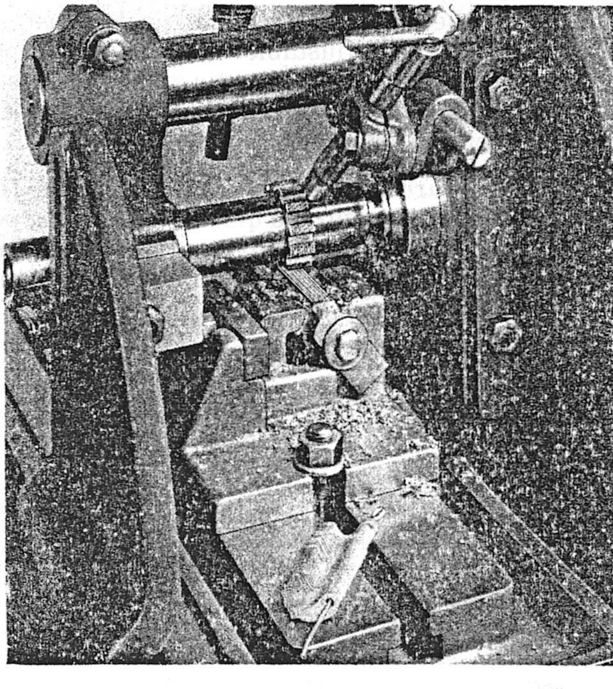


Fig. 14. A highly efficient set-up for milling V-grooves in screw pitch gage blades using a formed cutter. The fixture design and available length of table travel permit a large number of pieces to be machined at each loading; note group of blanks on table at lower part of picture.

In this set-up, and in the one shown above as well, the Wash-out Arrangement (connected to the Coolant System) provides a handy means of flushing out the fixture before loading.

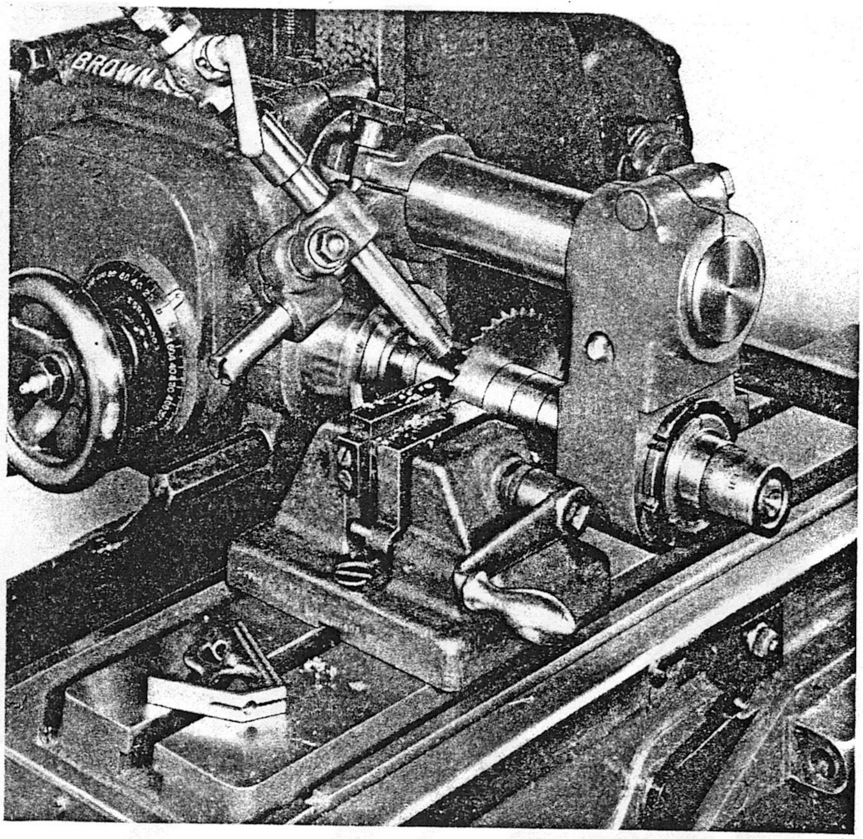


Fig. 15. Cutting a deep slot in the steel square head of a combination square. The fixture used provides for rapid loading and accurate location of the work, and the consistent accuracy of table reversal assures definite depth of slot in this blind cut. The cutter is mounted close to the spindle nose and the arbor yoke is placed close to the cutter to give a rigid cutter mounting.

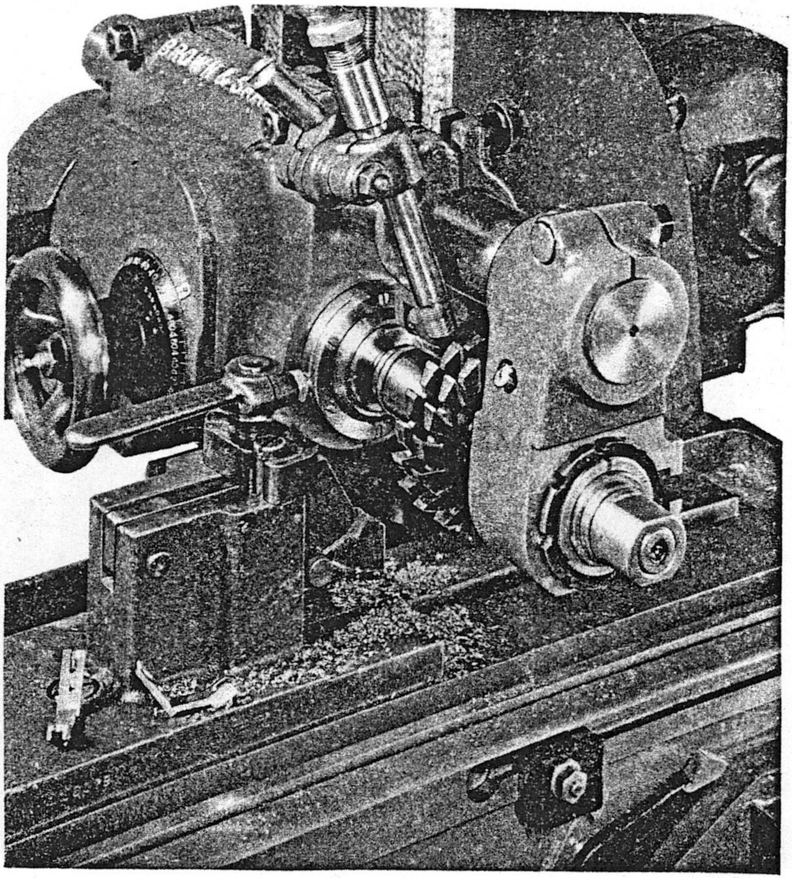


Fig. 16. A heavy cut in steel with a pair of side milling cutters arranged for straddle-milling the work to width. This is another blind-cut job, with accurate length of cut assured by the ability of the machine table to reverse consistently within an accuracy of .002". Working in steel with cutters of this diameter, a slow spindle speed is used.

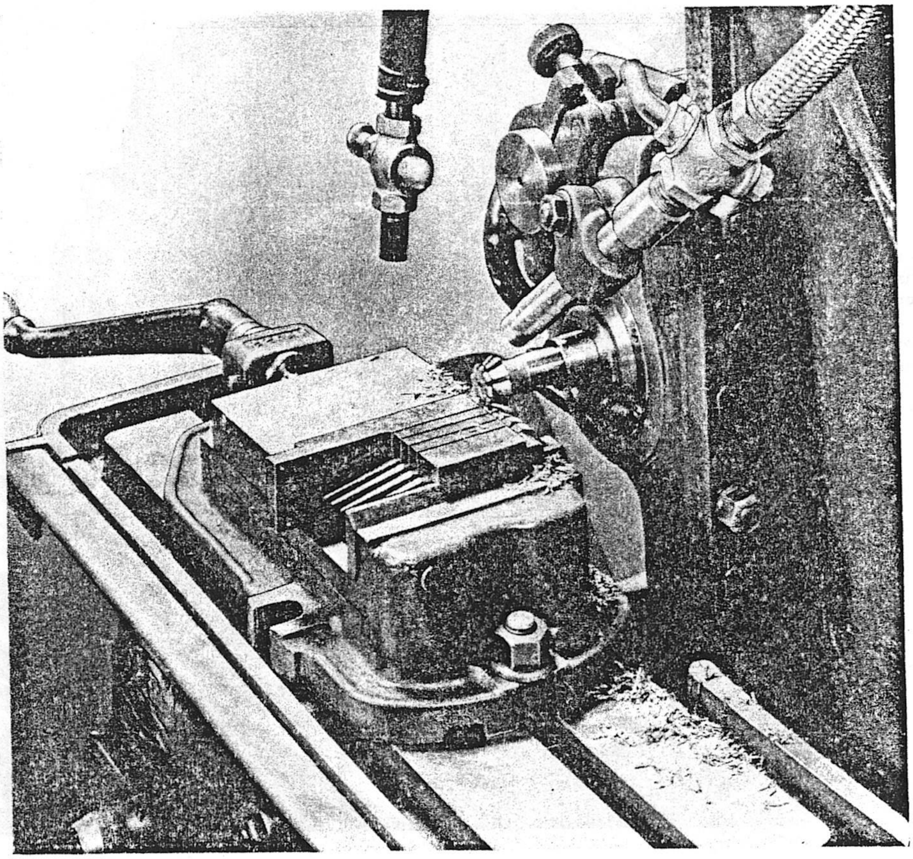


Fig. 17. Form-cutting the ends of steel divider legs. The small-diameter cutter used for this job is mounted in an adapter in the machine spindle, and a high spindle speed is used. Four pieces are machined at each loading, the work being held in special vise jaws.

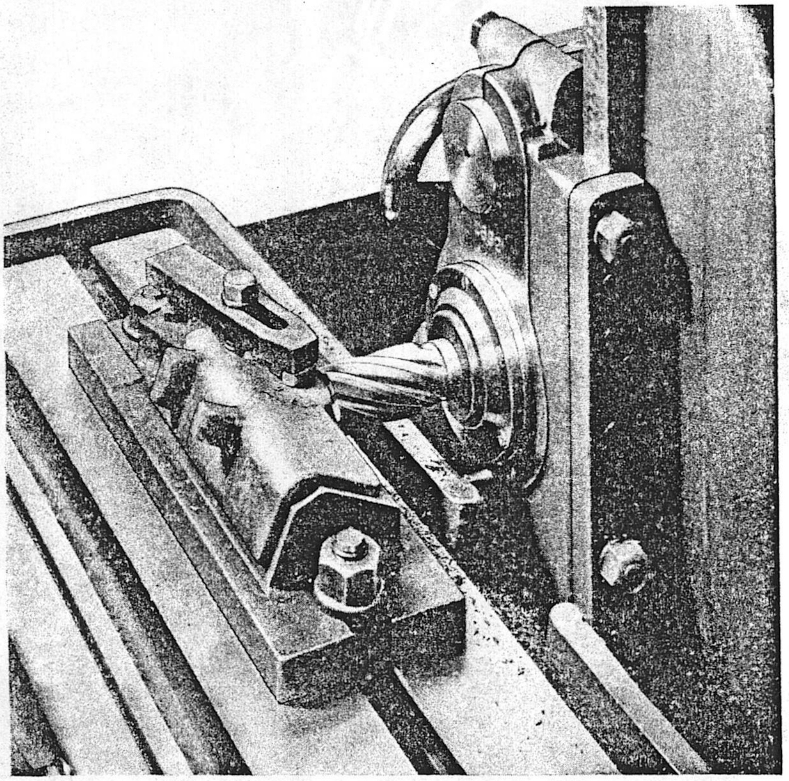


Fig. 18. Taking a facing cut on a boss on a cast iron cover, using an end mill mounted directly in the machine spindle. The work is clamped in a fixture, and depth of cut is determined by transverse adjustment of the spindle.

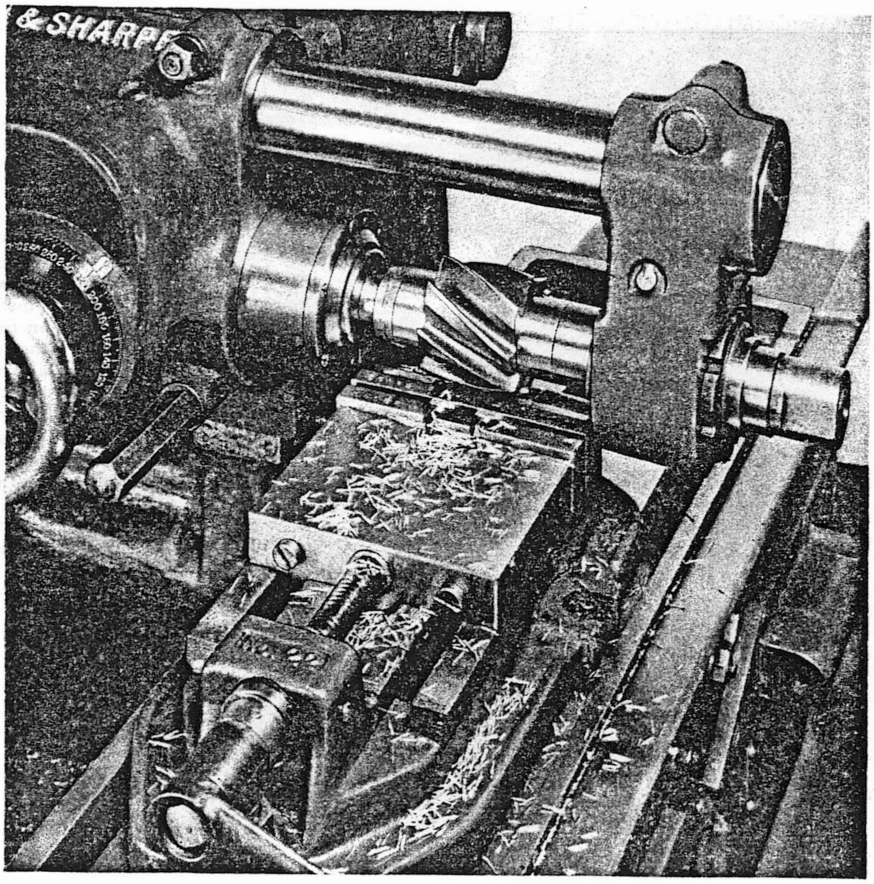


Fig. 19. Milling a flat on each of two small pieces held in special vise jaws. Since these parts are aluminum, a high spindle speed is used together with a fast rate of table feed, and coolant is omitted.

In general, on work where the length of cut is short the set-up man should be particularly careful to keep non-cutting time at a minimum, for on many jobs a waste of even two or three seconds represents a considerable percentage increase in the length of operating cycle. Locate the work so the cut will be completed just at the point of table reversal, and set the table dog so as to bring the work up close to the cutter at fast travel.

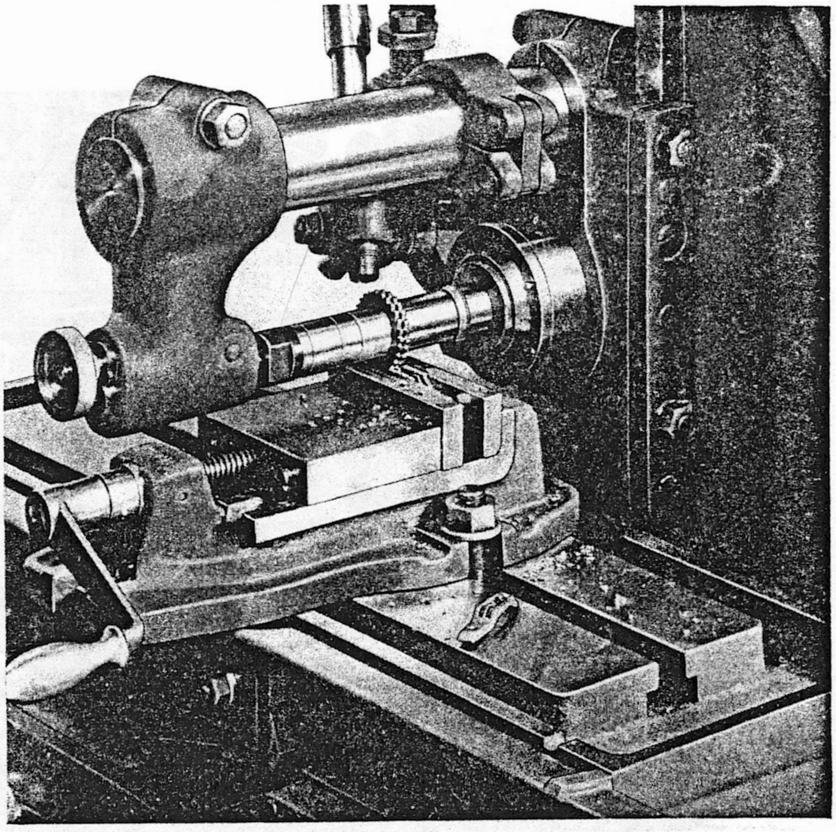


Fig. 20. Two slots are being milled in this thin steel sewing machine part. The conditions of speed, feed and depth of cut permit this job to be done by climb milling, which greatly simplifies the problem of holding this odd-shaped piece. The Arbor Center Head is used instead of the arbor yoke to provide clearance without using cutters of extreme diameter.

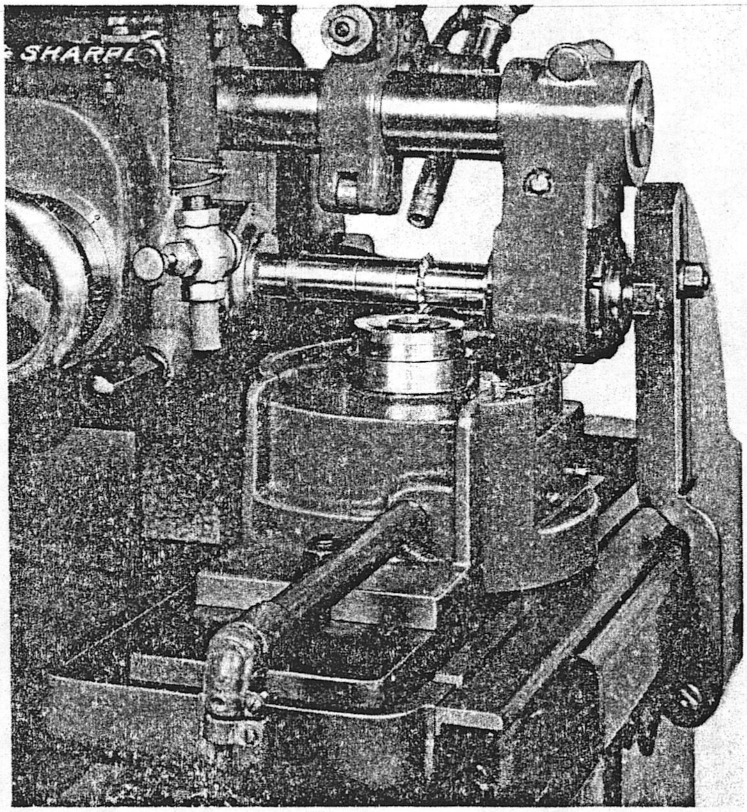


Fig. 21. This illustration and the three which follow show machines equipped with special automatic fixtures and controls which convert them into single-purpose production units of maximum efficiency.

The machine illustrated at left carries an automatic indexing fixture for cutting radial clutch teeth. The work is mounted on a vertical member which turns with an index plate inside the fixture. As the table moves to the right, a plunger in the fixture comes in contact with a spring-loaded plunger carried in a fixed bracket at the right, positively locating the index plate and locking it during the cut.

As the table returns in fast travel, the index plate is released and the work is then indexed approximately by means of a linkage on the table unit coming against a fixed stop. The table then advances automatically in fast travel for the next cut, and the cycle is repeated continuously until the piece is finished. A switch operated by the index plate stops the table in loading position on completion of the final cut.

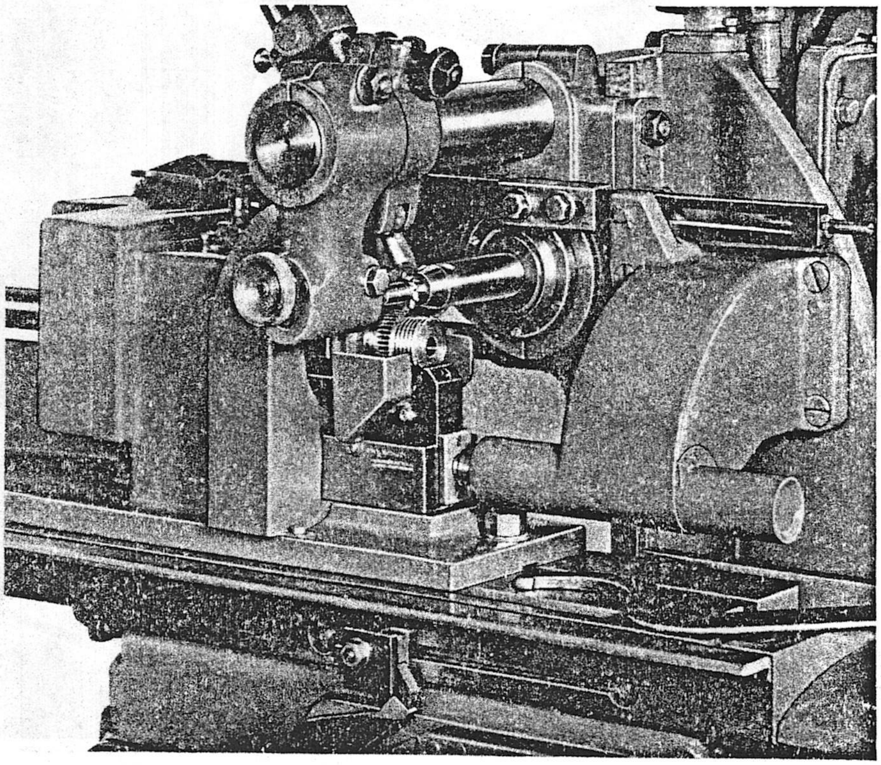


Fig. 22. Machine equipped with automatic indexing fixture for milling adjusting notches in the end of a machine gun barrel.

This arrangement works on the same principle as the one described above, the main difference being that the work in this case turns on a horizontal axis rather than a vertical one. Both arrangements can be designed to give any desired number of cuts per piece. Once started, the machine operates continuously until the piece is completed; then it stops automatically with the table in loading position.

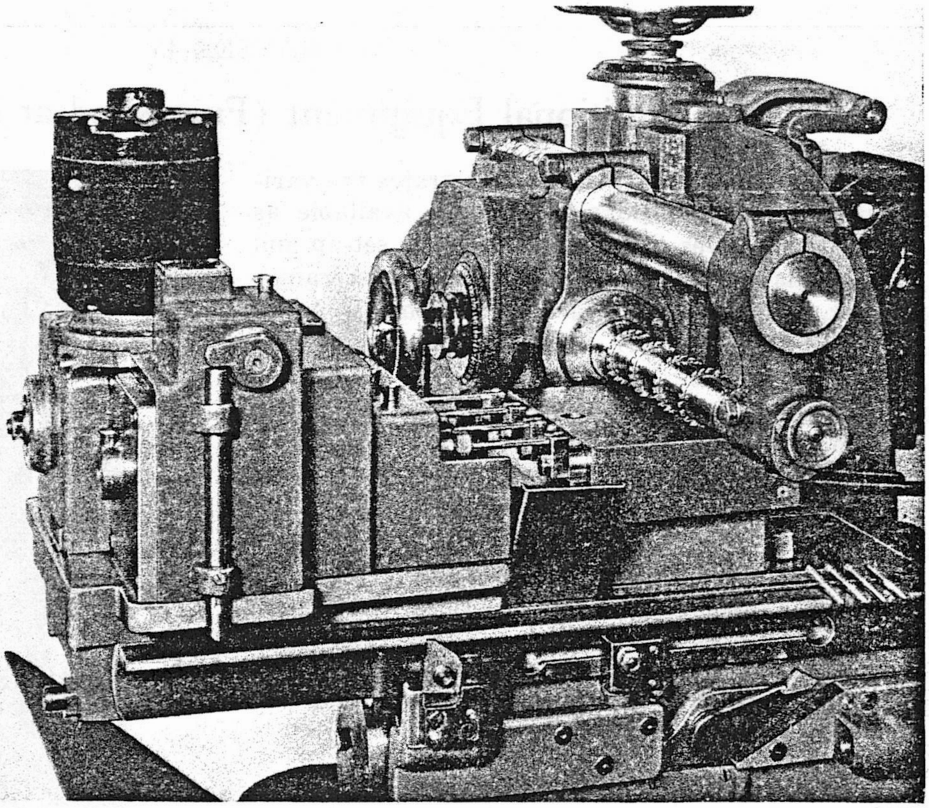


Fig. 23. Machine equipped with automatic multiple-spindle indexing fixture for milling tap flutes. The four indexing spindles have slotted conical holes to center and drive the squared ends of the taps, and the footstock spindles are operated individually for loading and unloading.

The operator loads the fixture and pulls the Start lever, and the first cut is taken in the regular manner. As the table returns in fast travel, the vertical rod on the front of the fixture is raised by the dog shown, thus withdrawing an index pin and allowing the torque motor illustrated to rotate the work to the next position. The table then advances automatically in fast travel for the next cut; and the process is repeated until all the flutes are cut, at which time the machine stops automatically with the table in loading position.

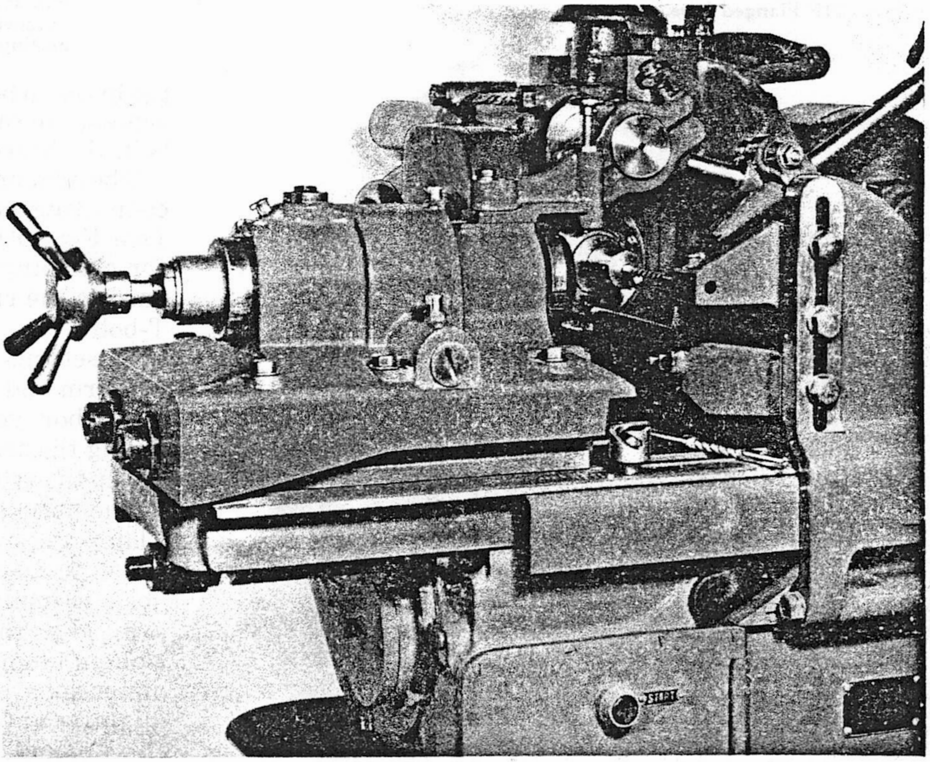


Fig. 24. Arrangement for cutting two helical slots in a hollow cylindrical part (see completed piece on front of table). The work is held in a sliding sleeve by a spring collet operated by the pilot wheel at left, and the two cuts are made simultaneously by a long straight-shank helical cutter supported at the outer end by a special yoke.

The upper part of the fixture is mounted on longitudinal ways on a base piece bolted to the machine table. As the work approaches the cutter, the upper part of the fixture meets a fixed stop. The table continues to advance; and the relative motion between the attachment base and the now stationary upper part turns a pinion in the upper part, thus moving the work-carrying sleeve toward the cutter. A cam slot in the sleeve causes the sleeve to turn as it advances and thus rotates the work to cut the helical slots.

At the end of the cut the table reverses in feed, and springs cause the upper part of the fixture to reverse direction to clear the work from the cutter. The table then returns to loading position at fast travel and stops.

CHAPTER IV

Additional Equipment (Furnished at Extra Cost)

This chapter describes and illustrates the various items of additional equipment available as extras and gives instructions on their set-up and use. This equipment includes a Wash-out Arrangement, Hinged Arm Brace Arrangement, Arbor Center Head, No. 21F Flanged Vise, No. 1C Cam Vise and Spindle Speed Reducing Unit.

Numerous cutters, arbors, adapters and collets suitable for use with this machine are listed in our catalogs; and we are prepared to make special cutters to meet any requirements.

Wash-out Arrangement

This Arrangement (Fig. 25) is convenient for flushing out the vise or fixture and the table channels. It consists of a spring-closed push valve, flexible tube, and piping for connection to the coolant system.

Hinged Arm Brace Arrangement

Fastened to the front of the bed by a horizontal hinge and bolted to the arbor yoke, this Arrangement (Fig. 25) provides the most rigid support for the arbor on the heavier cuts. The hinge permits the brace to be swung down out of the way for convenience in setting-up; and by taking out the hinge bolt, the brace may be removed from the machine.

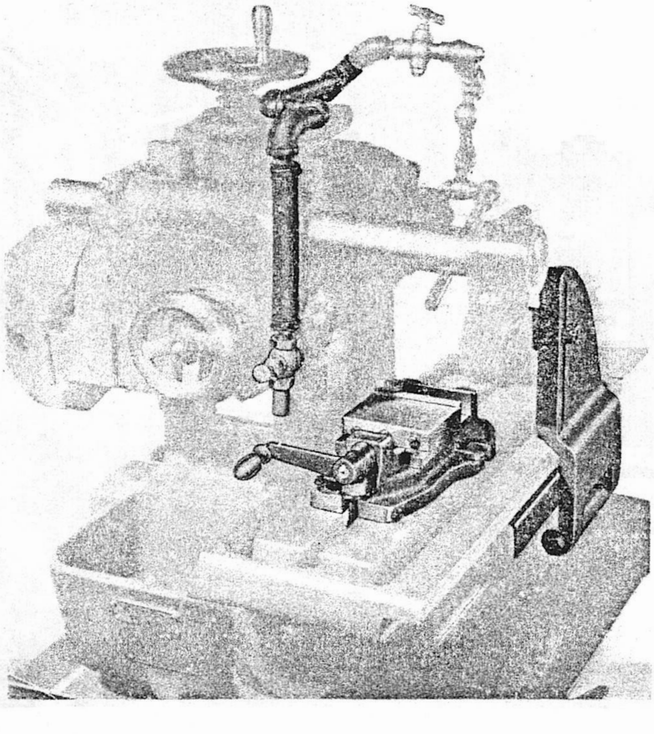


Fig. 25. Machine with Additional Equipment. Washout Arrangement, Hinged Arm Brace Arrangement and No. 21F Flanged Vise.

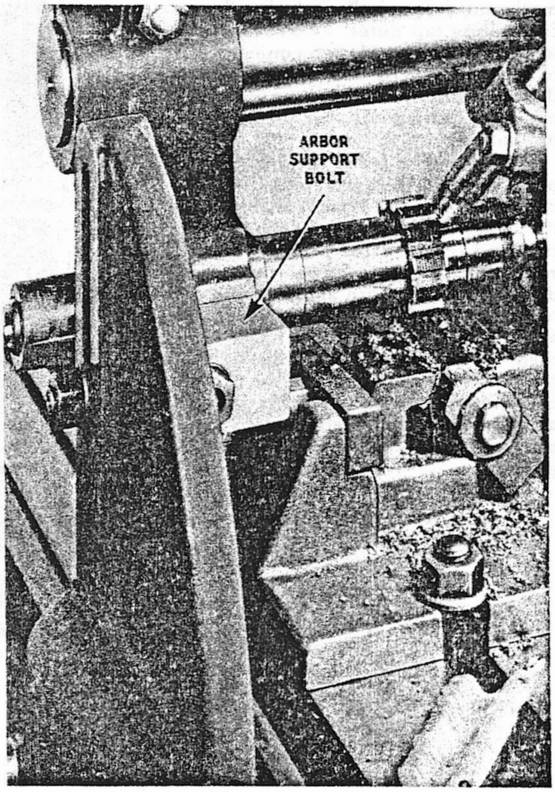


Fig. 26. Close-up of Hinged Arm Brace Arrangement showing arbor support bolt connecting arm brace with arbor yoke.

The arm brace is fastened to the arbor yoke by a connecting member called the arbor support bolt (see Fig. 26). This piece has a threaded portion for clamping to the arm brace, and is itself fastened to the right-hand side of the arbor yoke by a T-bolt.

In setting-up, first slip the arbor yoke onto the overarm and arbor. Put the arbor support bolt on the arbor yoke, leaving its T-bolt fairly loose. Swing the arm brace up into working position and clamp the arbor support bolt to it, keeping the body of the bolt flat against the back of the arm brace. Clamp the overarm in position; then tighten the T-bolt to fasten the arbor support bolt to the arbor yoke. Finally, clamp the arbor yoke to the overarm. (For the heaviest cuts it is also advisable to tighten the nut on the arm brace hinge bolt.) The dimensions of the parts involved assure proper alignment of the arbor yoke bushing with the machine spindle when the set-up is completed.

A sheet metal guard attached to the arm brace encloses the table feed trip dog when the brace is in operating position. For self-protection, the operator should see that this guard is in position before starting the machine.

In replacing the arm brace on the machine, be sure that the two steel washers marked *R* and *L* are placed between the arm brace and the hinge bracket on the bed, at the right and left sides of the bracket respectively.

Arbor Center Head

The Center Head (Fig. 27) is of value in certain cases where the arbor yoke regularly furnished does not allow sufficient clearance. It is recommended for use on the lighter cuts only, and cannot be used with the Hinged Arm Brace Arrangement.

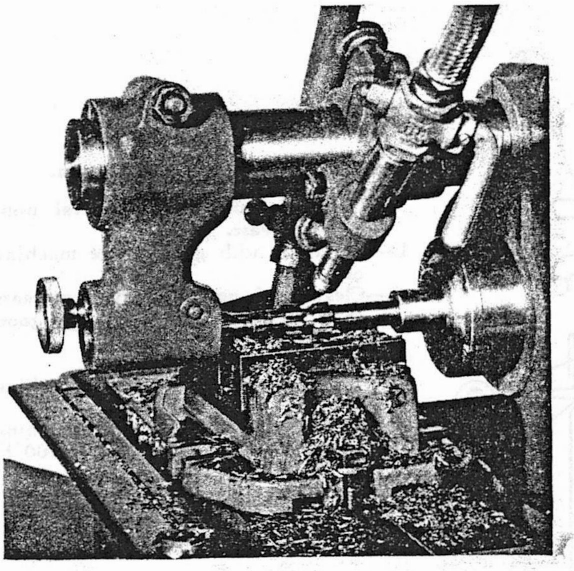
In setting-up, first seat the arbor securely in the spindle of the machine; then adjust and clamp the overarm. Move the head to seat the center in the arbor center hole. Then, with the spindle rotating (to keep the center lined up properly), clamp the Center Head to the overarm. Continuous spindle rotation without table movement is obtained as explained on page 11.

In using the Center Head, be careful not to force the center too tightly into the center hole of the arbor. Also, keep the center amply lubricated, particularly when using the higher spindle speeds.

No. 21F Flanged Vise

This vise is illustrated in Fig. 25. The removable hardened tool steel jaws are $4\frac{1}{8}''$ wide, $1\frac{1}{16}''$ deep, and open $2''$. These jaws are each held in place by two screws and can be readily replaced with special jaws formed to accommodate a given job.

Fig. 27. Arbor Center Head in use.



When using the vise, position the removable handle on the squared end of the vise screw so that when the work is firmly clamped the handle will be toward the front of the machine and nearly horizontal. This permits applying the greatest clamping pressure with the least effort, and also provides maximum travel of the movable jaw without relocating the handle on the screw.

No. 1C Cam Vise

Designed particularly for production work, the lever-operated Cam Vise (not illustrated) is quickly clamped and released and gives a strong, positive clamping action with minimum effort on the part of the operator.

The fixed jaw is fastened to the middle of the vise body. The movable jaw, at the end of the vise, has a tongue which extends under and beyond the fixed jaw. The cam pivot is clamped to this tongue and is locked by mating serrations; and the cam works against the fixed jaw to close the vise. A pin in the vise body acts against a cam surface on the underside of the cam to give positive release when the vise is opened.

The movable jaw should be set so that the clamp lever will be at approximately the end of its forward movement when securely clamping the smallest of the pieces to be machined. This vise can be used satisfactorily only on jobs where the variation in size of work-pieces is not greater than the $\frac{5}{64}''$ clamping range of the vise.

The removable hardened tool steel jaws are $4\frac{1}{8}''$ wide, $1\frac{1}{16}''$ deep, and have a maximum opening of $1\frac{3}{4}''$. These jaws are easily replaced with special jaws formed to accommodate a given job.

Spindle Speed Reducing Unit

This mechanism provides an additional spindle speed of 80 r.p.m. on machines with the regular 105 to 2340 r.p.m. speed range, and provides a speed of 120 r.p.m. on machines having a speed range of 161 to 3540 r.p.m.

The equipment consists of a single V-belt pulley and gear unit which is free to rotate on the back end of the spindle, and a mating gear keyed to the back gear shaft. The smallest-diameter cone pulley is used on the spindle motor, and the drive goes through the pair of gears to the back gear shaft and thence through the back gears to the spindle.

CHAPTER V

Maintenance

Installing or Relocating the Machine

In lifting or moving this machine, pass the hoisting rope from left to right between the bed and the base (above the coolant trough), parallel to the table (see Fig. 28). If a double rope is used, locate one rope at each side of the transverse adjustment handwheel at the left side of the spindle head; and on the right side of the machine pass the rope between the counterweight pulleys and the table. The weight of the machine is approximately 1220 lbs.

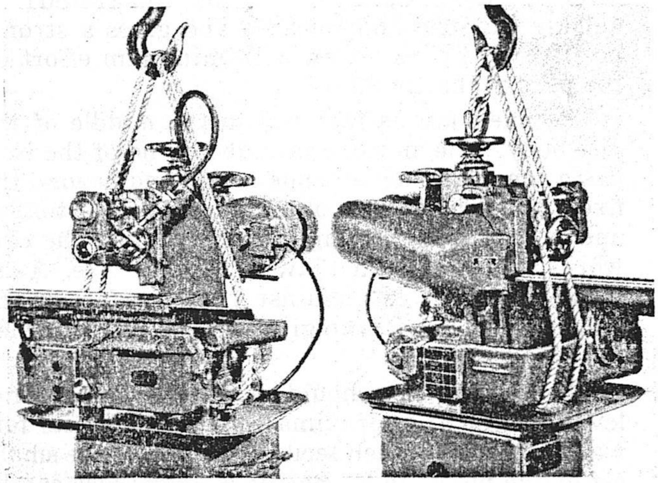


Fig. 28. Proper method of rigging machine with rope sling.

The machine should be located on a level and rigid floor which is free from heavy vibration.

With the machine in position, test the surface of the table both longitudinally and transversely with a precision spirit level and drive a wooden shingle under any corner or corners that may be low. Make sure that all four corners are supported; then tighten the lag screws, test the level of the table surface again in both directions and readjust if necessary.

The subject of connecting to the power supply is covered on page 28. CAUTION: To avoid damage, be sure to check the direction of motor rotation as explained on page 28 before starting to use the machine.

Lubrication

The gears and bearings in the spindle head are grease-lubricated and seldom require attention. Apply grease as instructed on the following page, and *do not* grease frequently or to excess.

The mechanisms in the bed are oiled automatically as described on page 25. The oil reservoir is drained before the machine is shipped from our factory, and must be filled before the machine is started. With the machine in operation, check the level of the oil reservoir weekly and refill as necessary; oil should show in the filler cup at all times (see Fig. 31). Also, look at the oil sight indicator now and then to make sure that the oiling system is operating.

Note further that there are four points (listed on page 26) which require occasional manual lubrication.

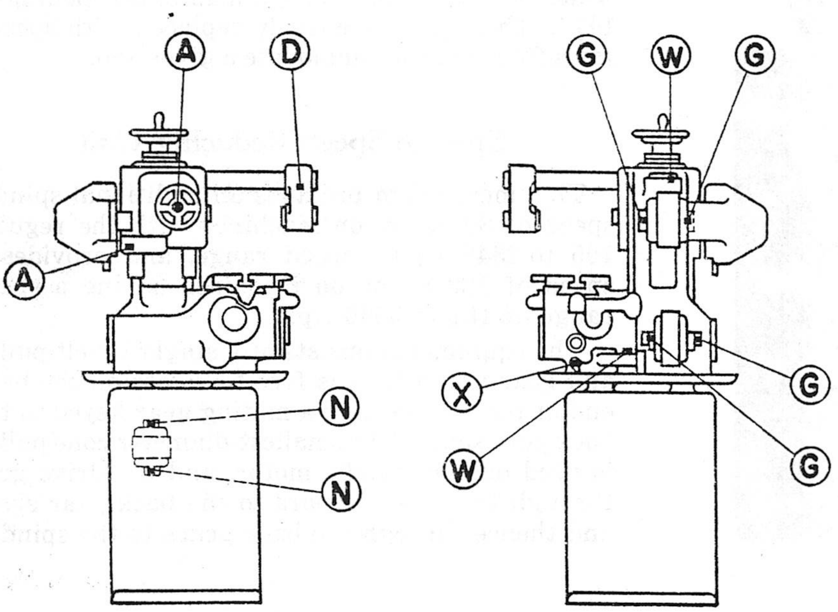


Fig. 29. Lubrication Diagram.

A—Grease annually with neutral non-fibrous grease.
D—Oil daily with good grade machine oil.
G—Clean and grease every two years (ball bearing motors) using good grade ball bearing grease.
N—Bearings permanently sealed.
W—Oil weekly with good grade machine oil.
X—Keep filled with good grade machine oil of S.U.V. 200 seconds at 100°F. or 10 S.A.E.

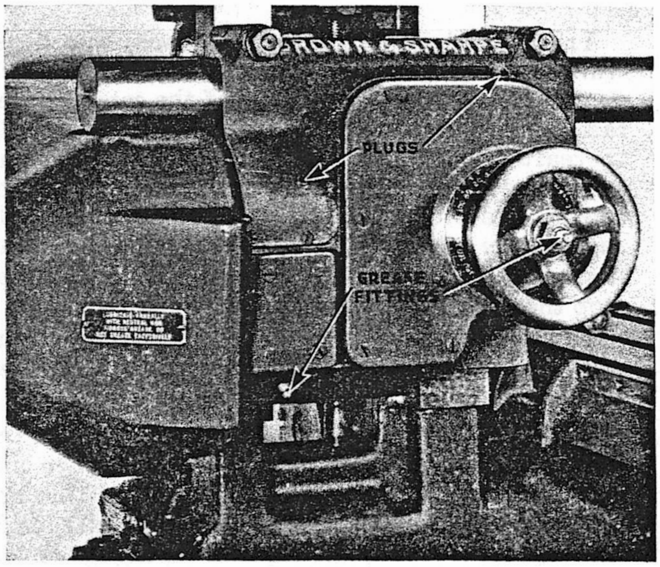


Fig. 30. Spindle head greasing points.

Spindle Head. Use a good grade of neutral nonfibrous bearing grease throughout. Do not grease any oftener than instructed, and do not apply excessive amounts of grease.

The spindle bearings are greased at assembly and, being sealed, seldom if ever require lubricating under normal conditions.

The back gear shaft and bearings are greased through the fitting on the lower left side of the head (see Fig. 30), and the transverse adjustment mechanism is greased through the fitting in the center of the handwheel. Both of these points should be greased once a year.

To avoid the possibility of the spindle driving pulleys rusting onto their shafts during long runs, the hole in each pulley is recessed slightly to hold a small amount of grease. Pack these recesses with grease whenever the pulleys are removed.

If the spindle head is disassembled, grease both sides of all ball bearings before replacing them. Then, with the cover plate on the left side of the head removed, grease the spindle bearings by taking out the two hollow-head plugs shown in Fig. 30, replacing with grease fittings and applying grease until it starts to come out of the bearings seen through the side of the spindle head. The upper hole lubricates the bearings in the spindle sleeve, and the lower hole greases the rear spindle bearings. Also, apply grease to the back gear shaft fitting until grease starts to come out of the bearing next to the back gear; and pack a handful of grease into the transverse adjustment mechanism and around the back gear.

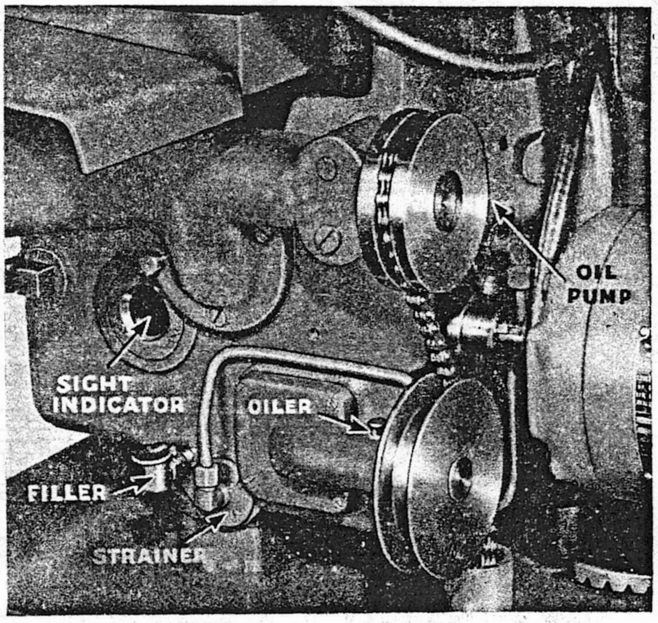
Table Mechanisms. The table ways and entire table driving mechanism are oiled by a plunger pump in the right rear of the bed (Fig. 32). The pump is driven by an eccentric on the constant-speed camshaft and operates whenever the table is moving.

The oil reservoir is in the bottom of the bed. The filler cup is on the right-hand end (Fig. 31), and the drain plug is on the underside of the bed at the rear of the change gear compartment. The oil strainer (Fig. 31) is held in by four screws and has a tapped hole for the oil tube fitting which can be used to facilitate pull-out. Oil goes from the strainer to the pump through an external oil tube.

Oil is delivered from the pump to the table ways through holes drilled in the bed casting. A tube under the right-hand portion of the table takes oil to the feed clutch, and a tube at the left end of the bed takes oil to the splined table shaft bearing. Also, oil is delivered through passages in the casting to the middle table shaft bearing, and flows from there through a tube to the counterweight pinion bearing. Oil returning from these points, together with oil passing through drip holes in the table ways, lubricates the camshaft bearings, cam and other parts; and the gears and bearings in the right-hand end are splash-lubricated by a slinger which receives oil through a tube from the pump. A window in the right-hand end of the bed permits observing the slinger as a check on the operation of the oiling system.

If it should be necessary to clean the oil passages or replace the tubes, note that the longitudinal oil passage in the rear table way contains a steel rod, and that the oil tube leading to the counterweight pinion bearing has a piece of wire in it. These pieces control the flow of oil for proper lubrication

Fig. 31. Filler, strainer, sight indicator and pump for automatic oiling system in bed.



and must be put back where they came from before reassembling the machine.

Points requiring manual lubrication are as follows:

— The counterweight idler pulley shaft should be lubricated weekly through the oiler near the pulley (Fig. 31).

— The arbor yoke bushing should be oiled daily or oftener as required, through the oiler provided.

— The shaft of the fast travel engagement knob (Fig. 1, page 7) should be given a few drops of oil now and then.

— The spindle head elevating screw and nut should be oiled occasionally through the oiler at the top of the spindle head casting near the screw (between the vertical ways).

Use a good grade of mineral oil having a viscosity of 300 S. S. U. at 100° F. or S. A. E. 20 throughout.

Motors. The table and spindle motors regularly furnished are of the ball bearing type. Every two years, remove and clean the bearings and grease with a good grade of ball bearing grease.

The bearings of the coolant pump motor are permanently sealed and require no attention.

Table Control Mechanism

The following explanation of how the table control mechanism operates will be of assistance to the maintenance man in making repairs or adjustments.

The table driving cam carries three trip dogs, which operate as follows: (1) A taper-ended dog or pin near the right-hand end of the cam engages fast travel as described below. (2) Immediately thereafter, the dog V (Fig. 32) near the left-hand end of the cam operates the reverse switch through a lever and plunger in the bed. (3) As the table reaches the left-hand end of its travel, dog U near the center of the cam operates the stop switch to stop the table at loading position.

For fast travel, the cam is driven directly by the jaw clutch in the right-hand portion of the bed (see Fig. 32).

When the adjustable table dog presses down the feed trip lever A (Figs. 33 and 34) to engage cutting feed, the movement is transmitted through parts B, C, D and E to the fast travel clutch shoe F, moving the clutch to the right to disengage it. At the same time, springs in the driving cam automatically apply pressure to friction clutch disks inside the bronze feed worm wheel (Fig. 32) to engage the feed drive. Also, the movement of part B (caused by the movement of lever A) brings the top of a latch block on the right-hand side of part B to a position below a mating block or finger on the upper left part of vertical lever G. The upper part of lever G then moves to the left under the action of compression spring K (at the lower end of G), thus engaging the latch; and the latch holds the clutch operating linkage in the feed position until released as described below.

When the table reaches the right-hand end of its movement, fast travel is engaged automatically as

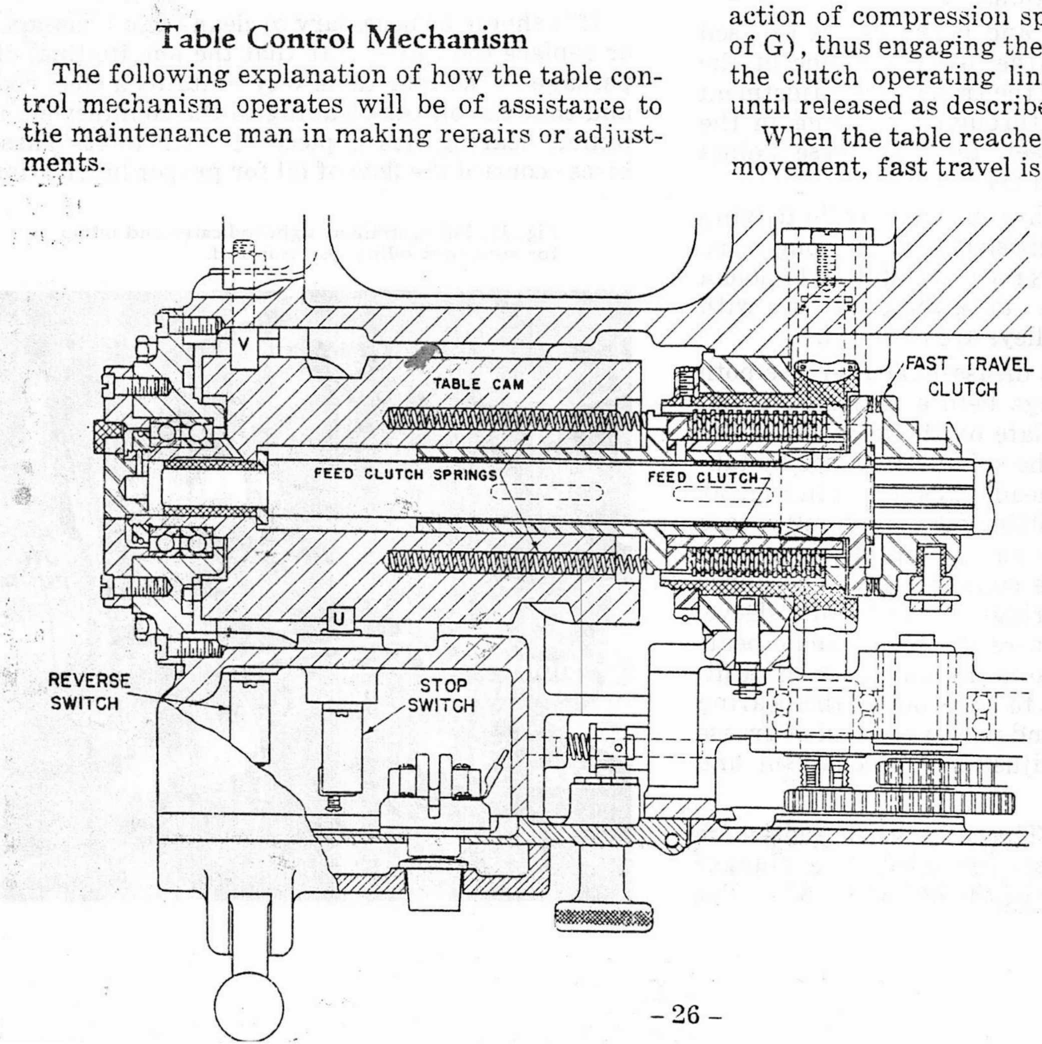
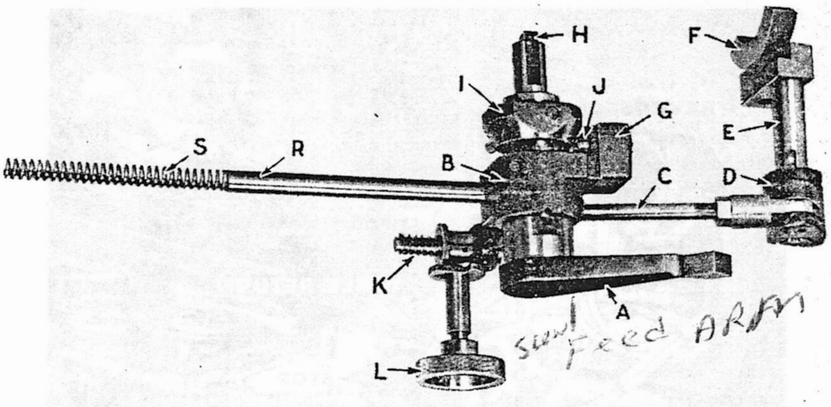


Fig. 32. Horizontal section through bed mechanism showing table cam, clutches and cam-operated switches.

Fig. 33



Figs. 33 and 34 show the clutch operating mechanism removed from the machine and set up in working position. Installed in the machine, part B is just behind the front wall of the bed casting, and rod R and spring S are in a horizontal hole drilled in the bed.

The individual parts of the entire mechanism are shown disassembled in the repair parts picture on page 38, and those here referred to by letters are given the repair parts numbers listed below. In ordering replacement parts, use the numbers and names given on page 39.

A — 2-9892
B — 2-9607
C — 2-8541
D — 2-9418
E — 2-9419
F — 2-9450
G — 2-8599
H — 2-8730
I — 2-8462
J — 2-8952
K — 4844
L — 91-72-4
R — 2-9001
S — 91-100-494

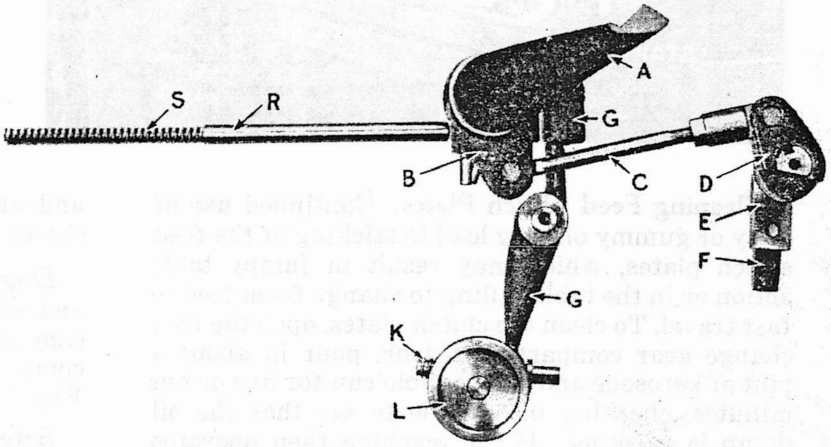


Fig. 34

follows: The taper-ended pin on the table cam comes against flip dog H (Fig. 33) and slides the cone-shaped piece I toward the front of the machine. The cone-shaped piece pushes against screw J in lever G, moving lever G to the right and thus disengaging the latch. This permits compression spring S and rod R, pressing on part B, to move the clutch operating linkage so that the fast travel clutch is brought to the engaged position. The feed clutch is automatically disengaged as the fast travel clutch engages.

When the knurled knob L is turned for manual engagement of fast travel, a pin on the back end of the knob shaft moves lever G to release the latch, and fast travel is engaged as above.

Mechanical Adjustments

Spindle Bearings. Under normal conditions the spindle bearings will give several years of service. When looseness eventually develops, remove the spindle and replace the bearings. In reassembling, lubricate as described on page 25.

Fast Travel Clutch. When the feed trip lever is in feed position and the trip dog has passed beyond it, the clearance between the two fast travel clutches should be .030″ to .040″. Insufficient clearance may result in a condition where the table moves at cutting feed for only a brief period after the feed trip dog has acted, advancing again in fast travel as soon as the dog leaves the feed trip lever. To increase the clearance, turn the fast travel clutch rod (part C, Fig. 34) to shorten it. Half a turn will usually be sufficient; a full turn will withdraw the clutch approximately .040″.

To free the left end of the fast travel clutch rod for making this adjustment, first release spring S (Fig. 34) by removing the retaining screw in the left-hand end of the bed. Then take off the cover plate on the front of the bed and remove the fast travel trip lever (part G). The pin which holds the fast travel clutch rod in position can now be removed and the rod released.

Latch Mechanism. If, after long-continued operation, the top edge of the hardened square block on the right-hand side of part B should become worn so that cutting feed does not remain engaged, take out lever G, remove the block in question, turn it 180° so as to present an unworn edge to the mating latch part on lever G and reassemble.

The upper part of lever G carries a screw J, as shown in Fig. 33. If a condition should ever arise where fast travel can be engaged by the fast travel knob but is *not* engaged automatically when the table reverses at the end of its feed movement, remove lever G and advance screw J half a turn.

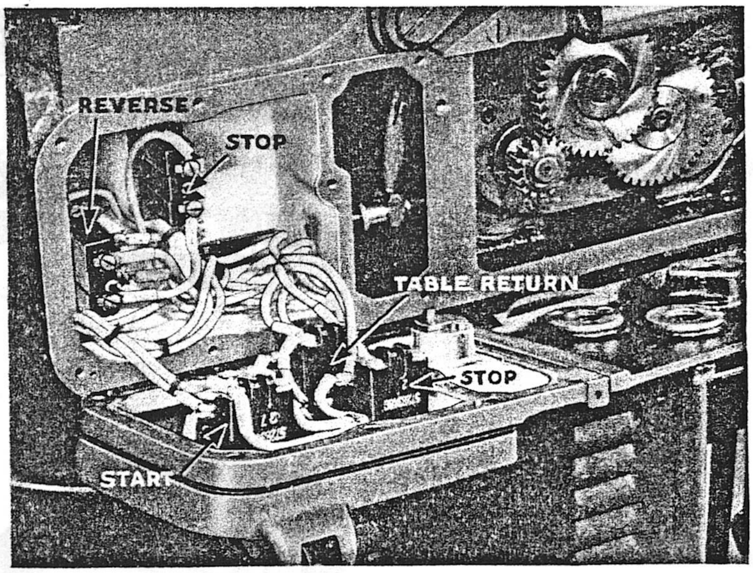


Fig. 35. Machine with cover plate on front of bed removed, showing manual control switches (mounted on cover plate) and dog-operated switches (on wall of bed casting).

Cleaning Feed Clutch Plates. Continued use of dirty or gummy oil may lead to sticking of the feed clutch plates, which may result in jumpy table action or in the table failing to change from feed to fast travel. To clean the clutch plates, open the feed change gear compartment door, pour in about a pint of kerosene and let the table run for five or ten minutes, checking meanwhile to see that the oil pump is working. If the machine then operates normally, drain the oil reservoir and refill with clean oil.

Electrical Controls

Connecting to Power Supply. The machine should be connected to the power line at the disconnect switch and should be properly grounded. The power wires are led into the machine through a junction box on the left-hand side of the bed.

Checking Motor Rotation. Before using a newly-connected machine, check the direction of rotation of the table motor as follows:

With a set of feed change gears in position on their shafts, set the table approximately central by means of the table adjustment crank (page 8) and push down the feed trip lever to engage cutting feed. Then close the gear compartment door and pull the Start lever. If the table moves from left to right the wiring is correct. If the table moves to the left, stop the machine immediately and correct the rotation of the table motor by reversing one phase of the power supply. Do not under any circumstances change the internal wiring of the machine.

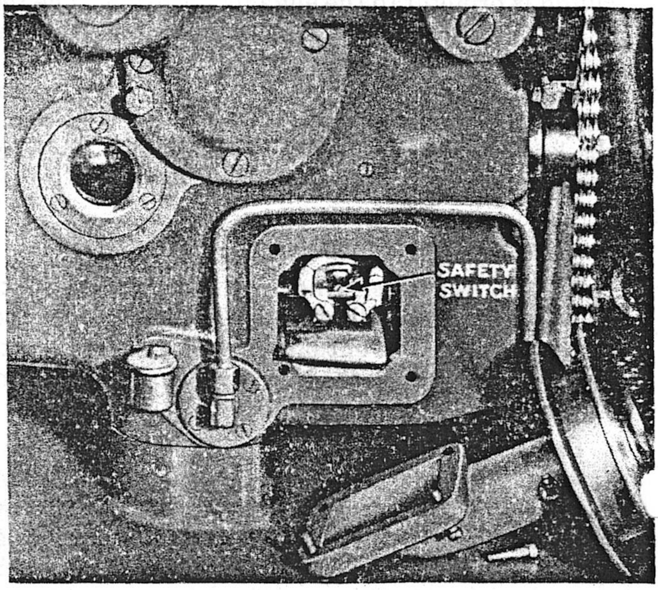
Manual Control Switches. The manually-operated Start, Stop and Table Return switches are mounted on the cover plate at the front of the bed, and are reached by removing the cover plate as shown in Fig. 35.

Dog-Operated Switches. The automatic reverse and stop switches operated by dogs on the table cam are mounted on the front wall of the bed in a compartment behind the front cover plate (see Fig. 35).

Safety Switch. The safety switch operated by the feed change gear compartment door is mounted in the right-hand end of the bed behind the counterweight idler pulley bracket as illustrated in Fig. 36.

Transformer. The transformer (Fig. 37) provides a control circuit voltage of 110 volts on 60-cycle power supply, and is protected by an overload

Fig. 36. Location of safety switch operated by feed change gear compartment door.



relay which is reset by pushing the red button at the left-hand side.

Control Equipment Units, illustrated and identified in Fig. 37, are mounted on a panel behind a hinged cover in a compartment in the rear of the machine base.

Trouble Shooting. Except for the coolant pump motor circuit, overload of any circuit stops the entire machine. In case of repeated stopping due to overload, determine which circuit is causing the trouble, as follows:

Start the machine and run it until it is stopped by a relay tripping out. After the relay has had time to cool, push reset plunger on spindle motor switch; if machine starts then spindle was overloaded. If machine fails to start, push table motor reset plunger and if machine starts, then overload is in table motor circuit.

The elementary and wiring diagrams sent with the machine will aid in further tracing of the trouble. If it becomes necessary to disconnect any wires, be careful to replace them properly according to the wiring diagram sent with the machine and the numbers on the terminals.

Cleaning the Contacts. The electrical equipment should be inspected about twice a year. At this time, or in trouble-shooting, the contacts of the manually-operated and magnetic switches may be cleaned with a rag if necessary. Never use sandpaper or emery for this purpose, since particles might adhere to the surface of the contacts and give serious trouble during operation. If an instance should occur where cleaning with a rag is not sufficient, use a very fine file. Note that the black substance on the contacts does no harm, and that removing this deposit will merely shorten the life of the contacts.

Operating Precautions

Much maintenance work can be avoided by keeping the machine clean and in good condition. By observing the following precautions, time lost for repairs and adjustment will be considerably reduced and the life of the machine will be extended.

See that the machine gets proper lubrication as described on pages 24 to 26. Also, check occasionally to see that the oil in the bed reservoir is clean, and clean out the oil strainer as necessary.

When using a vise or fixture which overhangs the table at the front, provide guards where necessary to prevent coolant from running down the front of the machine where it might enter the mechanism or lubricating system. If it is not practical to do this, use a non-corrosive cutting oil as coolant instead of soda or other coolants.

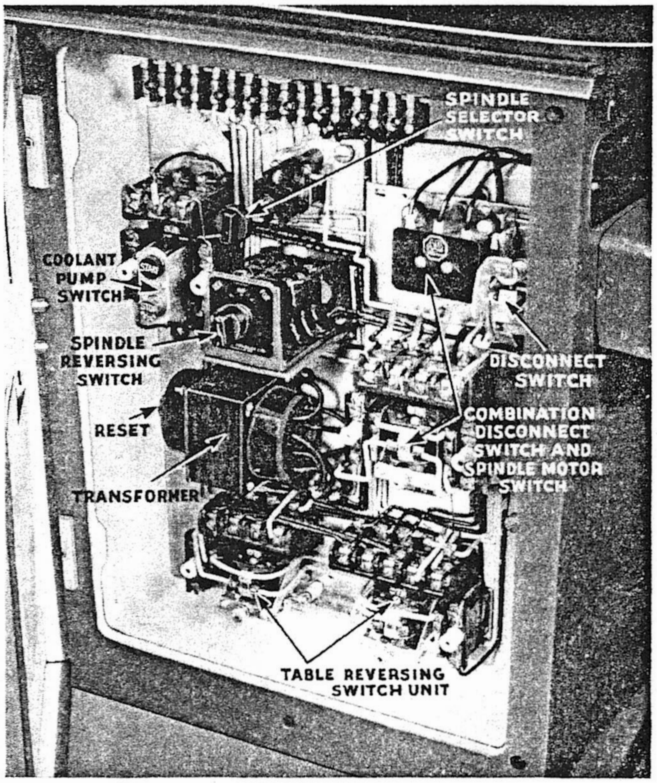


Fig. 37. Electrical controls in compartment in rear of base.

Do not use an excessive volume of coolant, and direct its flow so that it will not follow the arbor and run into the spindle head.

Do not allow chips to pile too high around the work or fixture, or to clog the T-slot and channels of the table.

Remember to clean out the chip tank and the coolant tank occasionally, and to clean the strainer around the coolant pump.

The use of compressed air for cleaning work and fixtures is not recommended, since the force of the blast and the resultant air currents will very likely carry dirt to parts of the machine which it otherwise could never reach — parts which cannot be protected by guards. If compressed air is used at all, be careful not to blow chips and dirt into the machine or into other machines near by. In general, it is much better to flush with coolant or, if necessary, to clean with a brush.

Keep the spindle driving belt at the proper tension as described on page 11.

PART II

REPAIR PARTS
for
No. 000 PLAIN MILLING MACHINE

For Machines Beginning Serial No. 2297

THE parts are arranged in the illustrations so far as possible in the same relative positions as in the machines. This is to facilitate stripping and assembling as well as identifying the parts.

The parts are shown separated to make the construction of the machines more readily understood and to show each part to best advantage. In some cases, when a particular part is ordered, not only that part but one or more supplementary parts also may be sent when, from our experience, this is known to be advisable for a more satisfactory repair job.

Repair parts, in some cases, will require fitting and therefore may need holes to be drilled, shoulders to be squared or similar machining in order to make them fit properly.

A scale of inches is located at the lower part of each Repair Parts illustration. This scale will be useful in determining the approximate size of the parts illustrated on that particular page.

HOW TO ORDER REPAIR PARTS

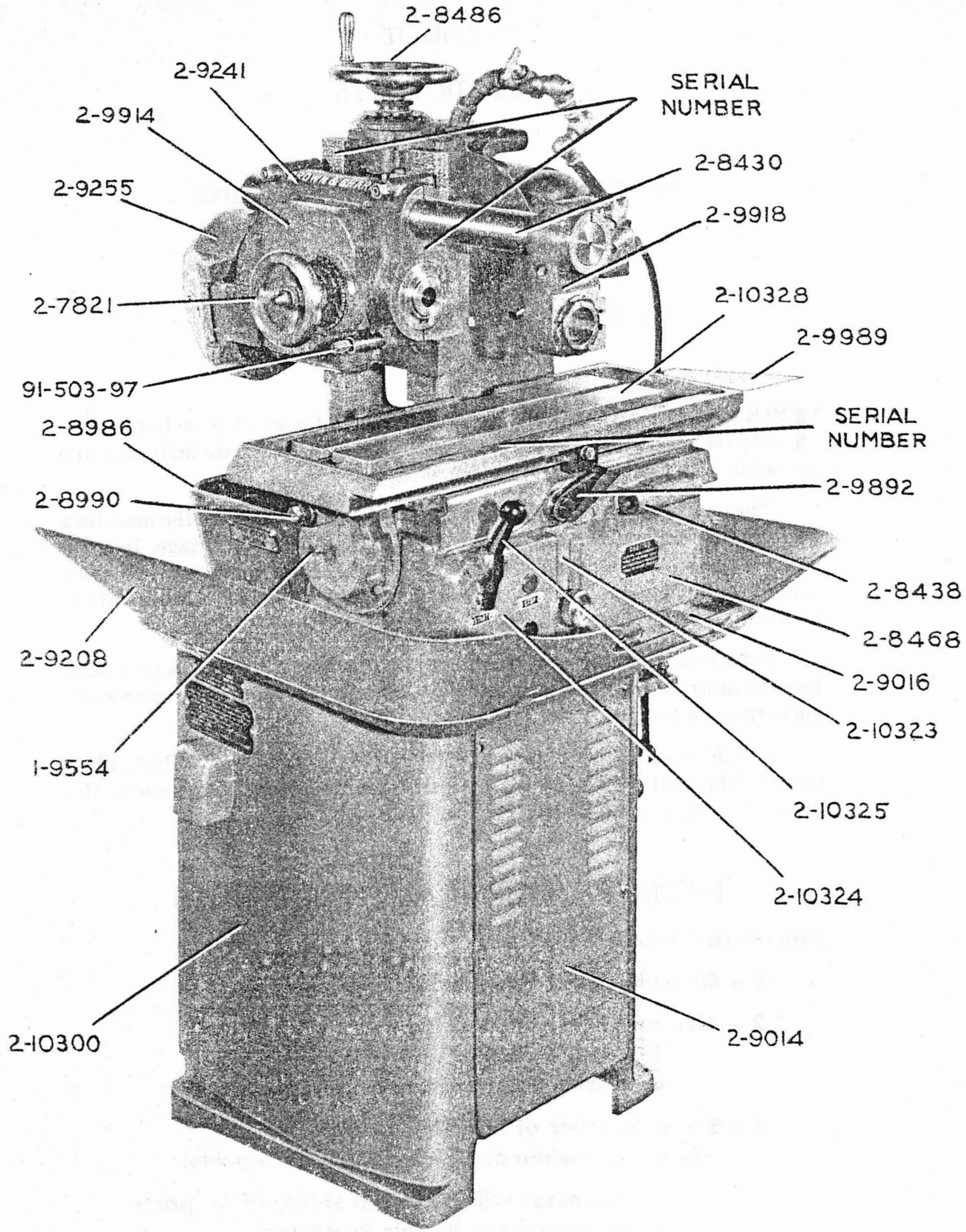
This information is essential:

1 – Quantity, Part Number and Name

2 – Size and Style of Machine
This will be found on the front
or side of the machine.

3 – Serial Number of Machine or Attachment
(Give both when ordering attachment parts)

This number will be found stamped on parts
as designated in Repair Parts Book.

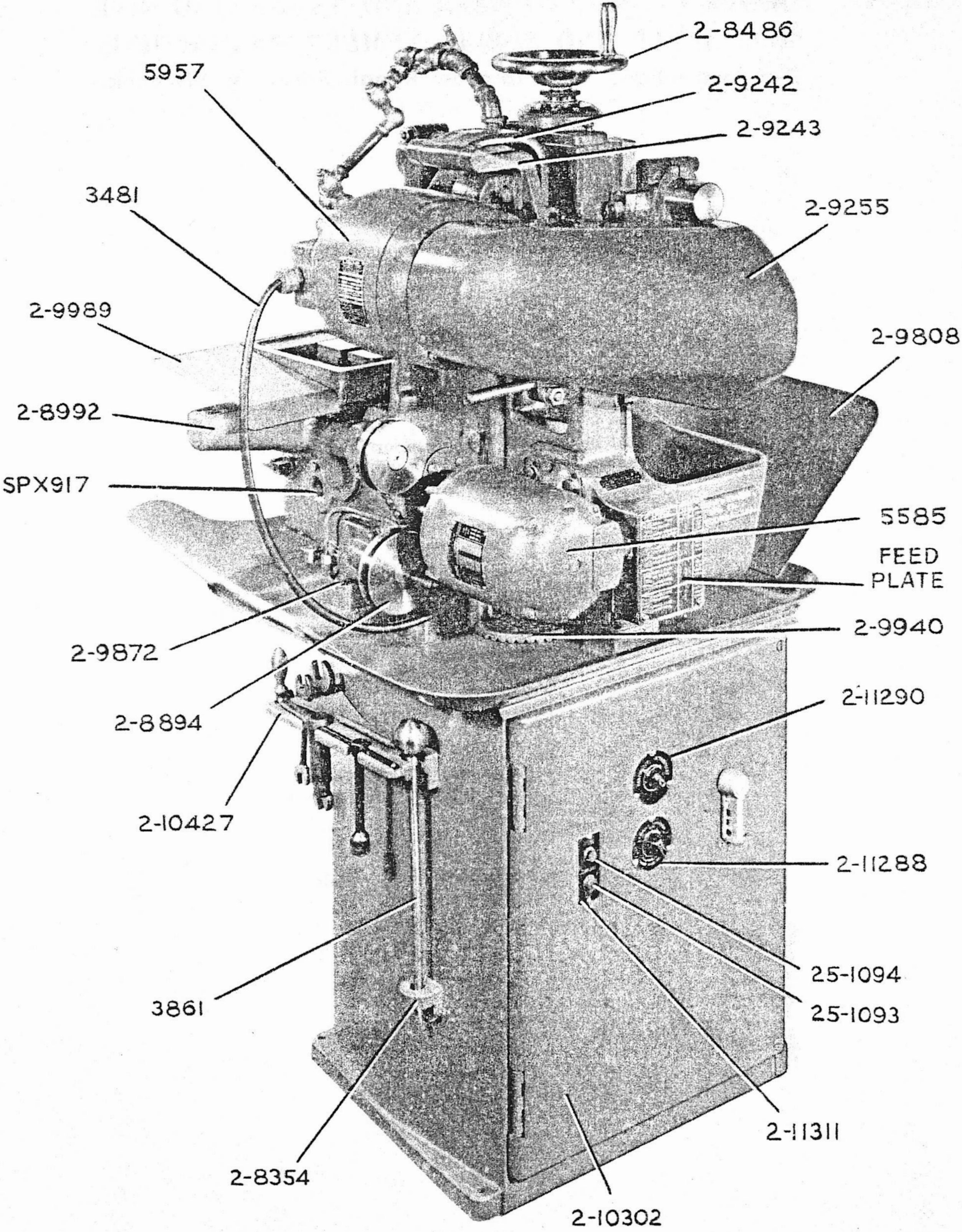

2-8486
2-9241
2-9914
SERIAL NUMBER
2-8430
2-9255
2-9918
2-7821
2-10328
2-9989
91-503-97
2-8986
SERIAL NUMBER
2-9892
2-8990
2-8438
2-8468
2-9208
2-9016
2-10323
1-9554
2-10325
2-10324
2-10300
2-9014

Front View

ORDER BY PART NUMBER AND NAME; ALSO GIVE *SIZE, STYLE* AND *SERIAL NUMBER* OF MACHINE.
(See instructions "How to order Repair Parts" in this book.)

Front View

1-9554	Cam Shaft Index Finger
2-7821	Spindle Adjusting Handwheel
2-8430	Arm
2-8438	Arbor Yoke Support Hinge Bracket
2-8468	Feed Change Gear Door
2-8486	Elevating Screw Handwheel
2-8986	Bed
2-8990	Table Shaft
2-9014	Base Cover, Front
2-9016	Coolant Trough, Complete
2-9208	Splash Guard
2-9241	Spindle Head (Includes 2-9914 and 91-503-97)
2-9255	Spindle Belt Guard, Complete
2-9892	Feed Trip Lever
2-9914	Spindle Head Cover
2-9918	Arbor Yoke
2-9989	Extension Bearing Guard
2-10300	Base
2-10323	Stop and Start Switch Cover
2-10324	Stop and Start Switch Cover Plate
2-10325	Starting Lever
2-10328	Table
91-503-97	Spindle Sleeve Clamp Bolt


2-8486
5957
2-9242
2-9243
3481
2-9255
2-9989
2-9808
2-8992
SPX917
5585
FEED PLATE
2-9940
2-9872
2-8894
2-11290
2-10427
2-11288
25-1094
3861
25-1093
2-11311
2-8354
2-10302

Rear View

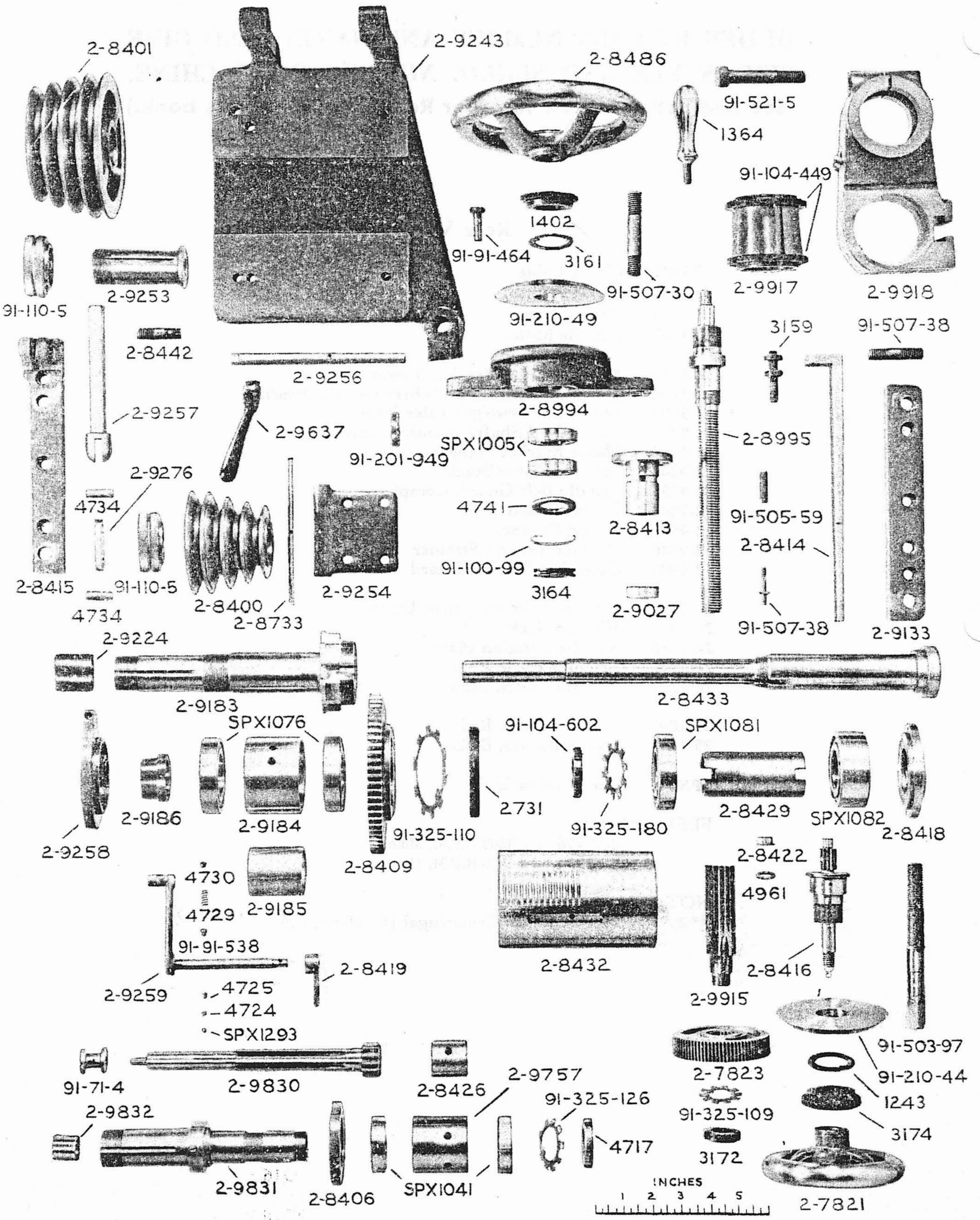
ORDER BY PART NUMBER AND NAME; ALSO GIVE *SIZE, STYLE* AND *SERIAL NUMBER* OF MACHINE.
(See instructions "How to order Repair Parts" in this book.)

Rear View

*3481	Motor Cable
3861	Knockout Rod
*5585	Table Motor
*5957	Spindle Motor
2-8354	Knockout Rod Bracket, Lower
2-8486	Elevating Screw Handwheel (Includes Handle)
2-8894	Feed Counterweight Idler Pulley
2-8992	Table Feed Shaft Extension Bearing
2-9242	Motor Bracket Hanger
2-9243	Spindle Motor Bracket
2-9255	Spindle Belt Guard, Complete
2-9808	Splash Guard
2-9872	Round Strainer
2-9940	Coolant Trough Strainer
2-9989	Extension Bearing Guard
2-10302	Electrical Compartment Door
2-10427	Wrench Rack
2-11288	Spindle Rotation Plate
2-11290	Machine Cycle Plate
2-11311	Coolant Switch Plate
25-1093	Switch Button, Red
25-1094	Switch Button, Black
SPX917	Oil Window Unit
FEED PLATE	
	2-11256 (For 1500 R.P.M. Motors)
	2-11294 (For 1800 R.P.M. Motors)
NOT SHOWN	
†*2997	Motor Driven Centrifugal (Coolant) Pump

*Give Complete Motor Name Plate Data.

†See Also "Repair Parts for Brown & Sharpe Pumps".



Spindle Head

ORDER BY PART NUMBER AND NAME; ALSO GIVE *SIZE, STYLE* AND *SERIAL NUMBER* OF MACHINE. (See instructions "How to order Repair Parts" in this book.)

Spindle Head

1243	Spindle Adjustment Driving Gear Washer
1364	Elevating Screw Handwheel Handle, Complete
1402	Elevating Screw Dial Nut
2731	Spindle Gear Nut
3159	Spindle Head Gib Screw and Nut
3161	Elevating Screw Dial Washer
3164	Elevating Screw Bearing Nut
3172	Spindle Sleeve Adjustment Pinion Nut
3174	Spindle Sleeve Adjustment Dial Nut
4717	Back Gear Shaft Sleeve Nut
4724	Back Gear Shaft Sleeve Spring
4725	Back Gear Shaft Sleeve Screw
4729	Safety Catch Spring
4730	Safety Catch Screw
4734	Spindle Motor Adjustment Link Pin
4741	Elevating Screw Bearing Washer
4961	Spindle Adjustment Gear (Driving) Washer
2-7821	Spindle Adjustment Handwheel (Includes 1364)
2-7823	Spindle Adjustment Driven Gear
2-8400	Spindle Drive Sheave, Small
2-8401	Spindle Drive Sheave, Large
2-8406	Back Gear Sleeve Bearing Cap
2-8409	Spindle Gear
2-8413	Elevating Screw Nut
2-8414	Spindle Head Gib
2-8415	Spindle Head Strap, Rear
2-8416	Spindle Adjustment Driving Gear
2-8418	Spindle Sleeve Cap
2-8419	Back Gear Safety Catch
2-8422	Spindle Adjustment Driving Gear Bushing
2-8426	Back Gear Sleeve Bearing Spacer, Inner
2-8427	Spindle, Complete (Includes 2-8418, 2-8429, 2-8432, 2-8433, 91-325-180, SPX1081 and SPX1082)
2-8429	Spindle Bearing Spacer, Front
2-8432	Spindle Sleeve
2-8433	Spindle (Includes 91-104-602)
2-8442	Spindle Motor Clamp Lever Stud
2-8486	Elevating Screw Handwheel (Includes 1364)
2-8733	Spindle Belt Guard Hinge Pin
2-8994	Elevating Screw Bracket
2-8995	Spindle Head Elevating Screw (Includes 1402, 3164 and 2-8413)
2-9027	Spindle Head Plug
2-9133	Spindle Head Strap, Front
2-9183	Spindle Gear Sleeve (Includes 2731, 2-8409, 2-9224 and 91-325-110)
2-9184	Spindle Bearing Rear Spacer, Outer
2-9185	Spindle Bearing Rear Spacer, Inner
2-9186	Spindle Rear Bearing Retainer
2-9224	Spindle Gear Sleeve Bushing
2-9243	Spindle Motor Bracket
2-9253	Motor Sleeve Sheave
2-9254	Spindle Belt Guard Hinge

2-9256	Spindle Motor Bracket Hinge Pin
2-9257	Spindle Motor Adjustment Stud
2-9258	Spindle Gear Sleeve Bearing Cap
2-9259	Safety Catch Lever
2-9276	Spindle Motor Adjustment Link
2-9637	Spindle Motor Adjustment Clamp Lever (For 25 Cycle Motor only)
2-9757	Back Gear Shaft Bearing Spacer, Outer
2-9830	Back Gear Shaft
2-9831	Back Gear Shaft Sleeve
2-9832	Back Gear Shaft Bushing
2-9915	Spindle Sleeve Adjustment Pinion (Includes 3172)
2-9917	Arbor Bushing (Includes 91-104-449)
2-9918	Arbor Yoke (Includes 2-9917 and 91-521-5)
91-71-4	Back Gear Shaft Knob
91-91-464	Elevating Screw Bracket Dowel
91-91-538	Safety Catch Detent
91-100-99	Elevating Screw Bearing Nut Spring
91-104-449	Arbor Bushing Nut
91-104-602	Spindle Nut
91-110-5	Spindle Drive Sheave Nut
91-201-949	Motor Bracket Hinge Pin Washer
91-210-44	Spindle Adjustment Handwheel Dial
91-210-49	Elevating Screw Dial
91-325-109	Spindle Sleeve Adjustment Pinion Lockwasher
91-325-110	Spindle Nut Lockwasher, Rear
91-325-126	Back Gear Shaft Sleeve Lockwasher
91-325-180	Spindle Nut Lockwasher
91-503-97	Spindle Sleeve Clamp Bolt
91-505-59	Spindle Head Strap Screw
91-507-30	Overarm Clamp Stud
91-507-38	Spindle Head Strap Clamp Bolt
91-521-5	Arbor Support Clamp Bolt
SPX1005	Elevating Screw Ball Bearing
SPX1041	Back Gear Shaft Sleeve Ball Bearing
SPX1076	Spindle Gear Sleeve Ball Bearing
SPX1081	Spindle Ball Bearing, Rear
SPX1082	Spindle Ball Bearing, Front
SPX1293	Back Gear Shaft Sleeve Ball

NOT SHOWN

2-9260 Guard Catch Stud, Complete

Spindle Speed Plate
- 2-11240 (60 Cycle 1800 R.P.M. Motor)
- 2-11254 (25 or 50 Cycle 1500 R.P.M. Motors)
- 2-11259 (60 Cycle 1200 R.P.M. Motor)
- 2-11316 (50 Cycle 1000 R.P.M. Motor)

Belt, Motor
- SPX210 (For Diehl Motors Only; "V" Belt ½" x 11/32" x 39" Long outside circumference)
- SPX214 ("V" Belt ½" x 11/16" x 38" Long outside circumference)

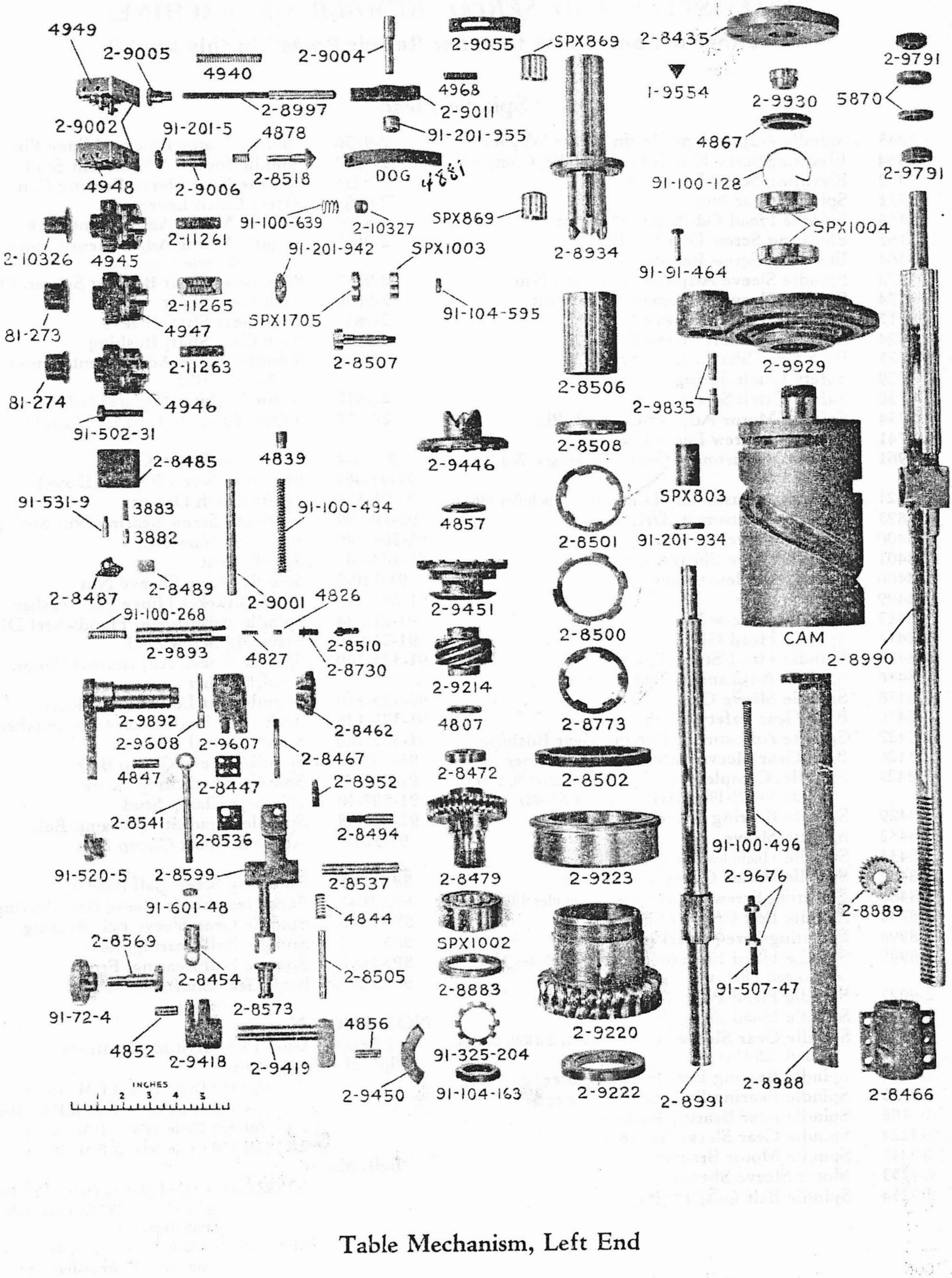


Table Mechanism, Left End

Table Mechanism, Left End

3882	Feed Trip Dog Plunger
3883	Feed Trip Dog Spring
4807	Table Cam Shaft Washer
4826	Control Shaft Flip Dog Plunger
4827	Control Shaft Flip Dog Spring
4839	Fast Travel Clutch Lever Spring Screw
4844	Trip Lever Spring Pin Spring
4847	Fast Travel Clutch Lever Pin, Left
4852	Fast Travel Clutch Lever Pin, Right
4856	Fast Travel Clutch Shoe Pin
4857	Fast Travel Clutch Washer, Left
4867	Table Cam Nut
4878	Stop Switch Plunger Spring
4940	Reverse Switch Operating Plunger Spring
4945	Start Push Button
4946	Stop Push Button
4947	Table Return Push Button
4948	Cam Stop Switch
4949	Dog Reverse Switch
4968	Reverse Operating Lever Adjusting Screw
5870	Table Shaft Nut Washer
1-9554	Cam Shaft Index Finger
2-8435	Cam Shaft Bearing Housing Cap
2-8447	Clutch Lever Latch Block
2-8454	Fast Travel Clutch Rod End
2-8462	Control Trip Sleeve
2-8466	Table Shaft Bearing
2-8467	Control Trip Sleeve Pin
2-8472	Lubricating Pump Cam
2-8479	Feed Motor Shaft Worm Wheel
2-8485	Feed Trip Dog Back (Includes 3882, 3883, 2-8487, 2-8489 and 91-531-9)
2-8487	Feed Trip Dog
2-8489	Table Dog Block
2-8494	Feed Worm Wheel Bearing Pin
2-8500	Cam Shaft Clutch Disk, Male
2-8501	Cam Shaft Clutch Disk, Female
2-8502	Feed Worm Wheel Nut, Outer
2-8505	Trip Lever Spring Pin
2-8506	Multi-Disk Clutch Sleeve
2-8507	Cam Roll
2-8508	Cam Clutch Washer
2-8510	Fast Travel Trip Pin
2-8518	Stop Switch Plunger
2-8536	Fast Travel Trip Lever Latch Block
2-8537	Fast Travel Trip Lever Pin
2-8541	Fast Travel Clutch Rod
2-8569	Fast Travel Trip Knob Shaft
2-8573	Fast Travel Trip Lever Sleeve
2-8599	Fast Travel Trip Lever (Includes 2-8536 and 2-8952)
2-8730	Control Shaft Flip Dog
2-8773	Cam Clutch Disk, Right
2-8883	Motor Worm Wheel Bearing Washer
2-8889	Table Feed Shaft Rack Pinion
2-8934	Cam Clutch (Includes SPX869)
2-8952	Fast Travel Trip Lever Trip Screw
2-8988	Table Gib
2-8990	Table Shaft (Includes 2-9791)
2-8991	Table Cam Shaft
2-8997	Reverse Switch Operating Plunger
2-9001	Fast Travel Clutch Lever Spring Plunger
2-9002	Cam Switch Mounting Plate
2-9004	Reverse Switch Operating Lever Pin
2-9005	Reverse Switch Operating Plunger Bushing
2-9006	Stop Switch Plunger Bushing
2-9011	Reverse Switch Operating Lever
2-9055	Table Cam Reverse Dog
2-9214	Feed Spiral Gear Driver
2-9220	Feed Worm Wheel (Includes 2-8502)
2-9222	Feed Worm Nut, Inner
2-9223	Feed Worm Wheel Bearing
2-9418	Fast Travel Clutch Lever, Right
2-9419	Fast Travel Clutch Lever Shaft
2-9446	Fast Travel Clutch, Left
2-9450	Fast Travel Clutch Shoe
2-9451	Fast Travel Clutch, Right
2-9607	Fast Travel Clutch Lever, Left (Includes 2-8447)
2-9608	Fast Travel Clutch Lever Pin
2-9676	Table Gib Screw Nut
2-9791	Table Shaft Nut
2-9835	Cam Stop Pin
2-9892	Feed Trip Lever
2-9893	Control Shaft (Includes 4826, 4827 and 2-8730)
2-9929	Cam Shaft Bearing Housing
2-9930	Cam Hole Plug
2-10326	Start Switch Button Plunger
2-10327	Start Lever Spring Button
2-11261	Start Plate
2-11263	Stop Plate
2-11265	Table Return Plate
81-273	Table Return Button
81-274	Stop Button
91-72-4	Fast Travel Trip Knob
91-91-464	Cam Shaft Bearing Housing Dowel
91-100-128	Feed Cam Nut Spring
91-100-268	Control Shaft Spring
91-100-494	Fast Travel Clutch Lever Spring
91-100-496	Cam Clutch Spring
91-100-639	Starting Lever Spring
91-104-163	Feed Motor Shaft Worm Wheel Nut
91-104-595	Cam Roll Nut
91-201-5	Stop Switch Plunger Washer
91-201-934	Cam Shaft Washer
91-201-942	Cam Roll Washer
91-201-955	Reverse Switch Operating Lever Spacer
91-325-204	Feed Motor Shaft Worm Wheel Lockwasher
91-502-31	Feed Trip Dog Bolt
91-507-47	Table Gib Screw
91-520-5	Table Feed Control Swivel Plug
91-531-9	Feed Trip Dog Stud
91-601-48	Fast Travel Clutch Rod Nut
SPX803	Cam Shaft Bushing
SPX869	Cam Clutch Bearing
SPX1002	Feed Motor Shaft Worm Wheel Ball Bearing
SPX1003	Cam Roll Ball Bearing
SPX1004	Table Cam Ball Bearing
SPX1705	Cam Roll Roller Bearing

Dog, Stop Switch Plunger

2-8973	(For 4½″ Table Travel)
2-9167	(For 25 or 50 Cycle, 1500 R.P.M. Motors)

Cam, Table

2-9928	(Includes SPX803)
2-9936	(Includes 2-8773 and SPX803; For 4½″ Table Travel)

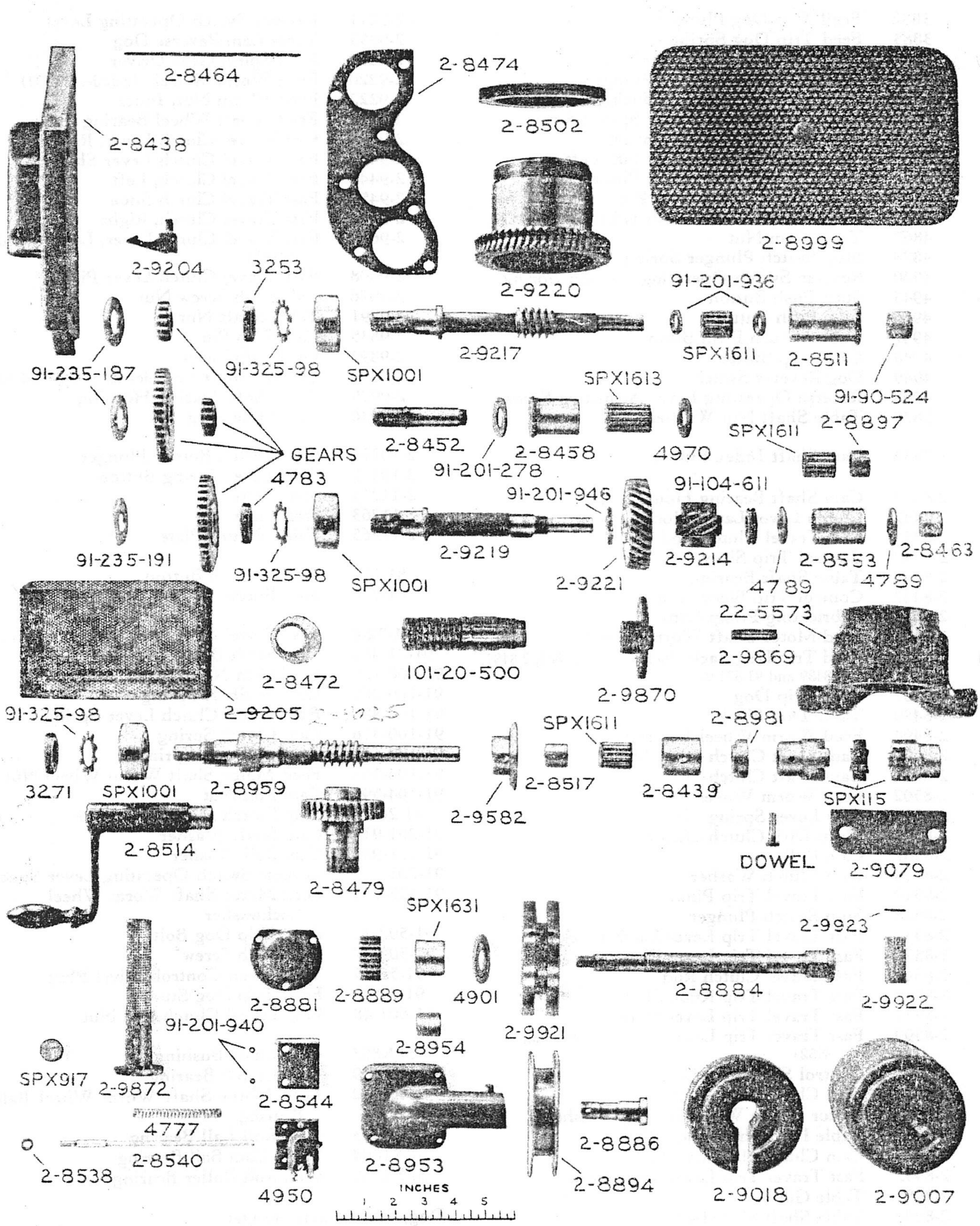


Table Mechanism, Right End

ORDER BY PART NUMBER AND NAME; ALSO GIVE *SIZE, STYLE* AND *SERIAL NUMBER* OF MACHINE.
(See instructions "How to order Repair Parts" in this book.)

Table Mechanism, Right End

3253	Feed Worm Shaft Nut
3271	Feed Motor Worm Shaft Nut
4777	Safety Switch Plunger Spring
4783	Feed Spiral Gear Shaft Nut, Front
4789	Feed Spiral Gear Shaft Washer
4901	Rack Pinion Shaft Washer
4950	Door Stop Switch
4970	Intermediate Gear Shaft Washer, Rear
2-8438	Arbor Yoke Support Hinge Bracket
2-8439	Feed Motor Worm Shaft Sleeve
2-8452	Feed Intermediate Gear Shaft
2-8458	Feed Intermediate Gear Shaft Bearing Sleeve
2-8463	Spiral Gear Shaft Hole Plug
2-8464	Feed Change Gear Door Hinge Pin
2-8472	Lubricating Pump Cam
2-8474	Gear Shaft Bearing Plate
2-8479	Feed Motor Shaft Worm Wheel
2-8502	Feed Worm Wheel Nut, Outer
2-8511	Feed Worm Bearing Sleeve
2-8514	Table Hand Feed Handle
2-8517	Feed Motor Worm Shaft Spacer
2-8538	Safety Switch Operating Plunger Screw
2-8540	Safety Switch Operating Plunger
2-8544	Safety Switch Bracket
2-8553	Spiral Gear Shaft Bearing Sleeve
2-8881	Extension Bearing Cap
2-8884	Rack Pinion Shaft
2-8886	Feed Counter weight Idler Pulley Stud
2-8889	Table Feed Shaft Rack Pinion
2-8894	Feed Counterweight Idler Pulley
2-8897	Spiral Gear Shaft Bearing Spacer
2-8953	Counterweight Pulley Bracket
2-8954	Rack Pinion Shaft Bearing Inner Race
2-8959	Feed Motor Worm Shaft (Includes 3271)
2-8981	Feed Motor Worm Shaft Bushing
2-8999	Chip Strainer
2-9007	Table Feed Counterweight, Lower
2-9018	Table Feed Counterweight, Upper
2-9079	Feed Motor Shim
2-9204	Latch Holder
2-9205	Coolant Pump Strainer
2-9214	Feed Spiral Gear, Driver
2-9217	Feed Worm (Includes 3253)
2-9219	Feed Spiral Gear Shaft
2-9220	Feed Worm Wheel (Includes 2-8502)
2-9221	Feed Spiral Gear, Driven
2-9582	Motor Worm Shaft Oil Slinger
2-9869	Lubricating Pump Nipple
2-9870	Pump Hole Cover

2-9872	Round Strainer
2-9921	Counterweight Chain Pulley
2-9922	Counterweight Chain Block
2-9923	Counterweight Chain Pin
2-9987	Counterweight Chain, Complete (Includes 2-9921, 2-9922, 2-9923 and SPX398)
22-5573	Coolant Pump Support, Complete
91-90-524	Feed Worm Shaft Hole Plug
91-104-611	Feed Spiral Gear Shaft Nut
91-201-278	Feed Intermediate Gear Shaft Washer
91-201-936	Roller Bearing Cage Washer
91-201-940	Safety Switch Bracket Washer
91-201-946	Feed Spiral Gear Washer
91-235-187	Feed Change Gear Retainer
91-235-191	Spiral Gear Shaft Gear Retainer
91-325-98	Feed Spiral Gear Shaft Lockwasher
91-325-98	Feed Worm Lockwasher
91-325-98	Feed Motor Worm Shaft Lockwasher
101-20-500	Lubricating Pump, Complete
SPX115	Coupling
SPX917	Oil Window
SPX1001	Feed Motor Worm Shaft Ball Bearing
SPX1001	Feed Worm Ball Bearing
SPX1001	Feed Spiral Gear Shaft Ball Bearing
SPX1611	Feed Spiral Gear Shaft Roller Bearing
SPX1611	Feed Worm Roller Bearing
SPX1611	Feed Motor Worm Shaft Roller Bearing
SPX1613	Feed Intermediate Gear Shaft Roller Bearing
SPX1631	Table Feed Shaft Extension Roller Bearing

Gears, Feed Change

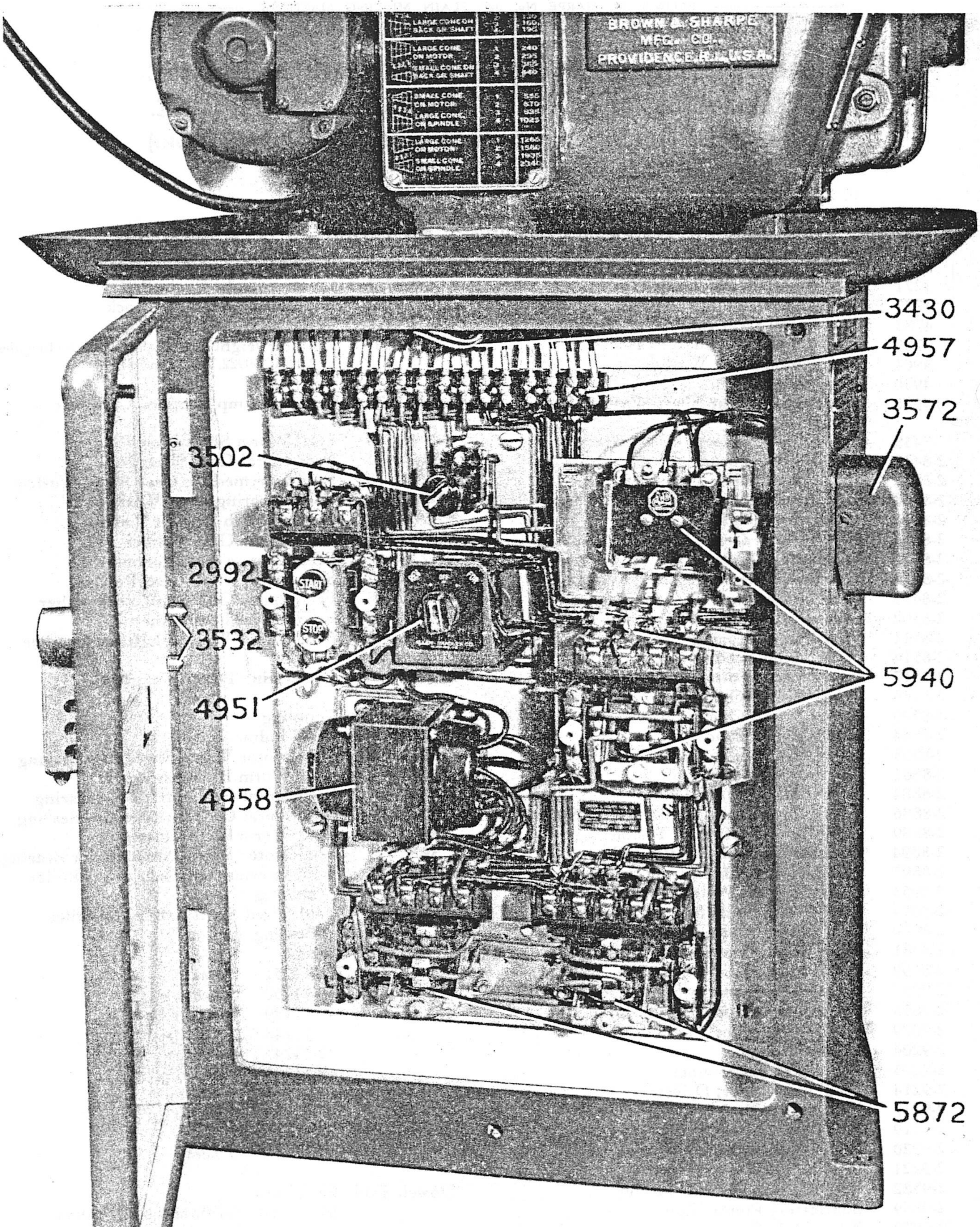
42-11251	15 Teeth
42-11250	16 Teeth
42-11249	19 Teeth
42-11248	22 Teeth
42-11247	26 Teeth
42-11246	29 Teeth
42-11245	33 Teeth
42-11244	36 Teeth
42-11243	39 Teeth
42-11242	40 Teeth

Dowel, Table Feed Motor

91-91-464	(For Diehl and G.E. Motors)
91-91-214	(For Howell Motors)

NOT SHOWN

SPX398	Counterweight Chain



Electrical Control Panel

ORDER BY PART NUMBER AND NAME; ALSO GIVE *SIZE, STYLE* AND *SERIAL NUMBER* OF MACHINE.
(See instructions "How to order Repair Parts" in this book.)

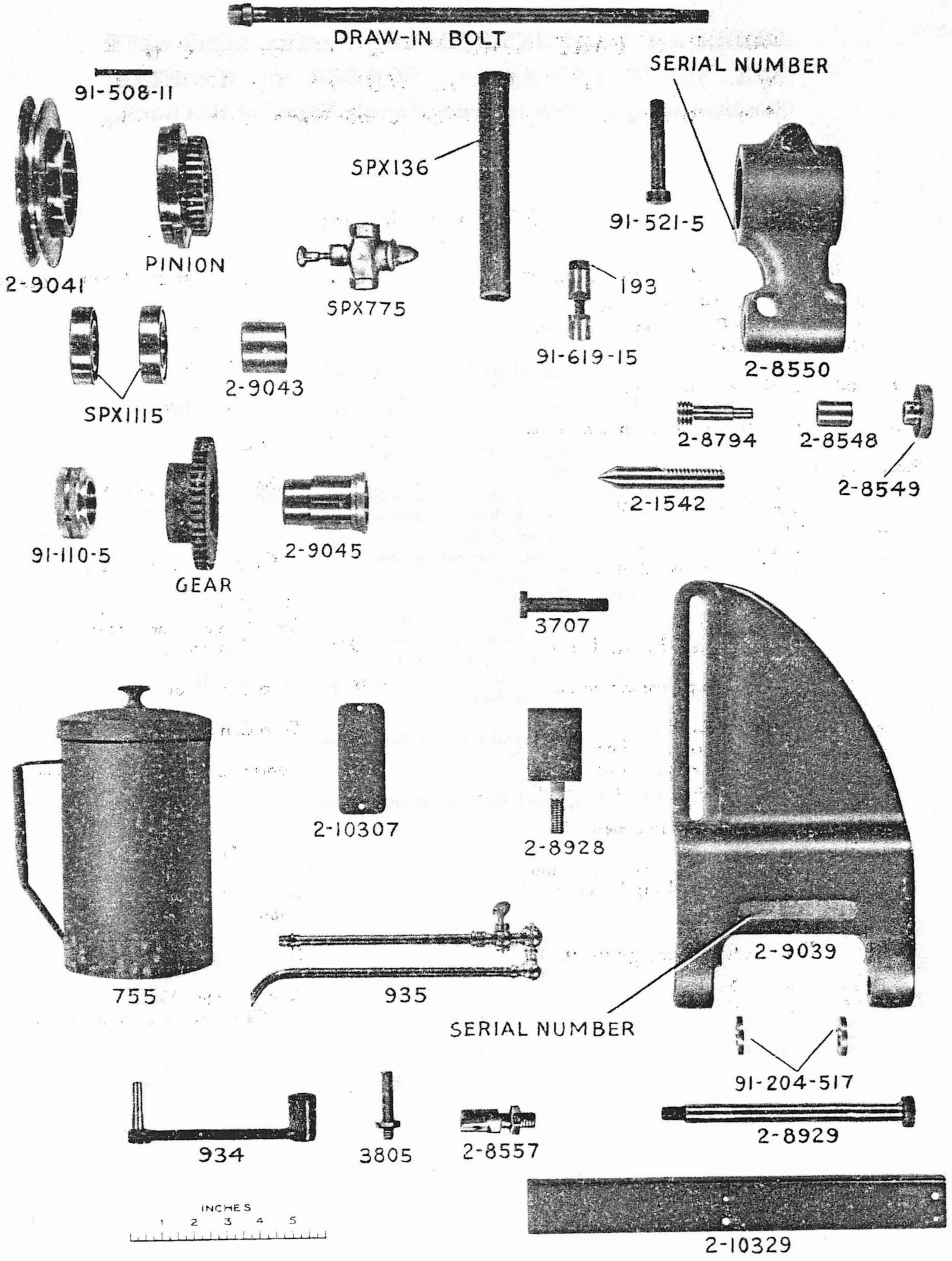
Electrical Control Panel

State Voltage, Frequency and Phase of Power Supply

2992	Coolant Pump Switch
3430	Wiring Harness
3502	Intermittent Control Selector Switch
3532	Switch Button Extension
3572	Terminal Box
4951	Spindle Reversing Switch
4957	Terminal Block
4958	Transformer
5872	Table Reversing Switch Unit (Includes both L and R Contactors and Overload Relays)
5940	Combination Disconnect Switch and Spindle Motor Switch
2-10312	Electrical Control Panel, Complete

NOT SHOWN

91-100-458	Switch Button Extension Spring



Additional Equipment

ORDER BY PART NUMBER AND NAME; ALSO GIVE *SIZE, STYLE* AND *SERIAL NUMBER* OF MACHINE.

(See instructions "How to order Repair Parts" in this book.)

Additional Equipment

Spindle Speed Reducing Unit

2-9041	Spindle Driving Sheave
2-9043	Spindle Driving Sheave Spacer
2-9045	Back Gear Shaft Gear Sleeve
91-110-5	Back Gear Sleeve Nut
SPX1115	Spindle Driving Sheave Ball Bearing

Pinion, Spindle Driving Sheave
  2-9042
  2-9071 (For 1800 R.P.M. Motor)

Gear, Back Gear Shaft
  2-9044
  2-9072 (For 1800 R.P.M. Motor)

Arbor Center Head Unit

193	Center Clamp Bushing Screw
2-1542	Arbor Center Head
2-8548	Center Adjustment Worm Bushing
2-8549	Center Adjustment Worm Knob
2-8550	Arbor Center Head (Includes 193, 2-1542, 2-8548, 2-8549, 91-521-5 and 91-619-15)
2-8794	Arbor Center Adjustment Worm
91-521-5	Arbor Center Adjustment Clamp Bolt
91-619-15	Arbor Center Clamp Bushing

Wash-Out Arrangement

SPX136	Flexible Hose
SPX775	Push Valve

Hinged Arm Brace Arrangement

3707	Arbor Yoke Bolt
2-8928	Arbor Support Bolt
2-8929	Hinge Bolt
2-9039	Arbor Yoke Support
2-10329	Dog Guard
91-204-517	Arbor Yoke Support Washer

Coolant Drip Can

755	Drip Can
934	Drip Can Support Extension
935	Drip Can Spout
3805	Drip Can Pivot
2-8557	Drip Can Support
2-10307	Coolant Switch Opening Cover

Draw-In Bolt

2-8457 (N.C. Thread)
2-9666 (B&S Thread)

NOT SHOWN

*21F Flanged Vise
*1C Cam Vise (State Width of T-Slot)

*See also "Repair Parts for Brown & Sharpe Vises".